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TRACTION OF BOATS BY CABLE.

UPON large watercourses the towage of convoys of barges is generally effected either by means of a steam tug or of a tow boat which takes its point of support upon a chain immersed in the river. On the majority of canals, on the contrary, the small section of the navigable way and the relatively large number of locks reduce the speed and length of the convoys too much to allow of the effective use of the two modes of traction just mentioned. Hitherto, it has been necessary almost everywhere to haul each boat separately, the traction being performed by men or animals.

Endeavors have been made, but up to the present without success, to utilize mechanical power. The most rational solution appears to be the application of the cable system used upon tramways. If, in fact, an endless cable actuated by a steam motor or a waterfall be installed upon the banks, the boats will merely have to be attached separately to this moving cable in order to be carried along with the same speed upon the canal. The main difficulties consist in the mode of attaching the boats and in the oscillations and twisting of the cable.

We shall now see how the problem has been solved by Mr. Maurice Levy, a learned member of the Institute, in the experiments undertaken by him at Joinville-le-Pont, at the junction point of the Saint Maur and Saint Maurice Canals. This point was especially selected because the canals meet here at right angles, this being quite a rare circumstance and one which presents the most difficulty as regards the turning of the boats. An endless metallic cable is installed upon each bank at a few yards from the edge, in order to leave the tow-path free. It is supported here and there by channeled pulleys, which are loose upon metallic supports, from six to ten feet in height. On a straight line, these pulleys are vertical and are ten inches in diameter. On curves, they are more or less inclined, and have a diameter of five feet. At its starting point, the cable passes over three large pulleys actuated by a steam engine placed in a small shed at the edge of the canal. To the right, there is a fourth pulley carried by a small car provided with a counterpoise which serves to keep the cable uniformly taut. The latter moves in the direction shown by the arrows in our engravings.

Here and there, the cable is provided with links to which is affixed the cord that carries the boat along. These links, fixed between rings, are capable of revolving freely upon the cable, so as to avoid inconveniences of the latter's tension.

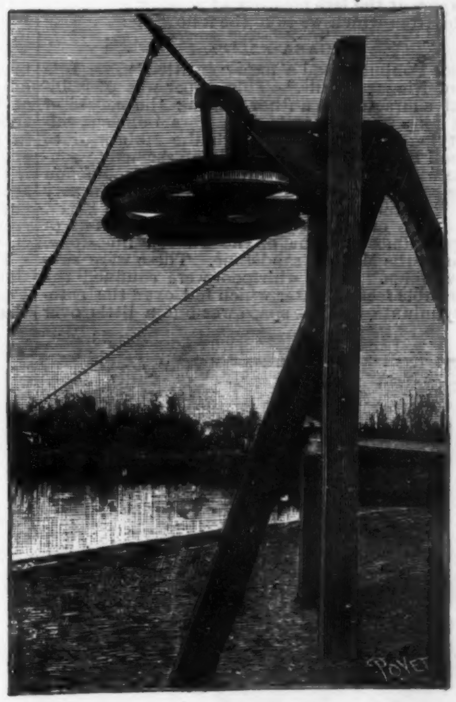
In order to prevent the cable from jumping out of the channels of the pulleys, it is held therein by means of a small roller fixed upon the same support as the pulleys. These latter are provided with several notches in order to allow the links to pass.

Let us suppose that a boat wants to be carried along by the moving cable. A man proceeds to the bank in a rowboat carrying the tow line, which latter he passes into the link by means of a boat hook and attaches it to a small fastening and unfastening device which is connected with the boat by a cord. Then he returns to the boat, which has now got under way through the action of the cable.

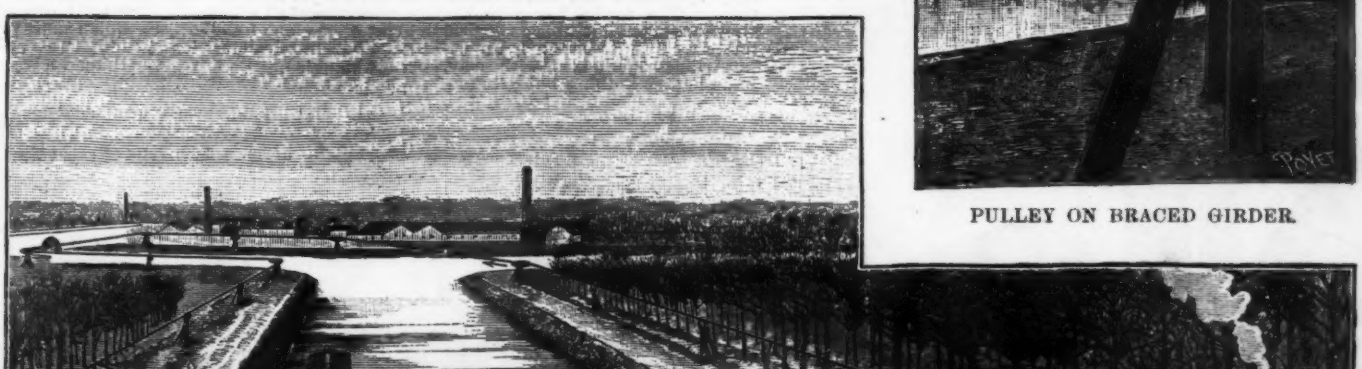
Jerks at the starting are avoided by paying out a short length of the tow line, either by means of a small windlass or by allowing it to unwind around a cleat. This maneuver can be performed by the man at the rudder.

With this new system of traction, two men per boat are sufficient, as is usually the case on canals. If a motor and engineman are necessary, the horses and their driver are done away with. When it is desired to render the boat independent of the cable, it suffices to ease up a little on the tow line or give the cord of the unfastening device a pull. The click operates and frees

BOAT TOWED BY CABLE.



PULLEY ON BRACED GIRDER.

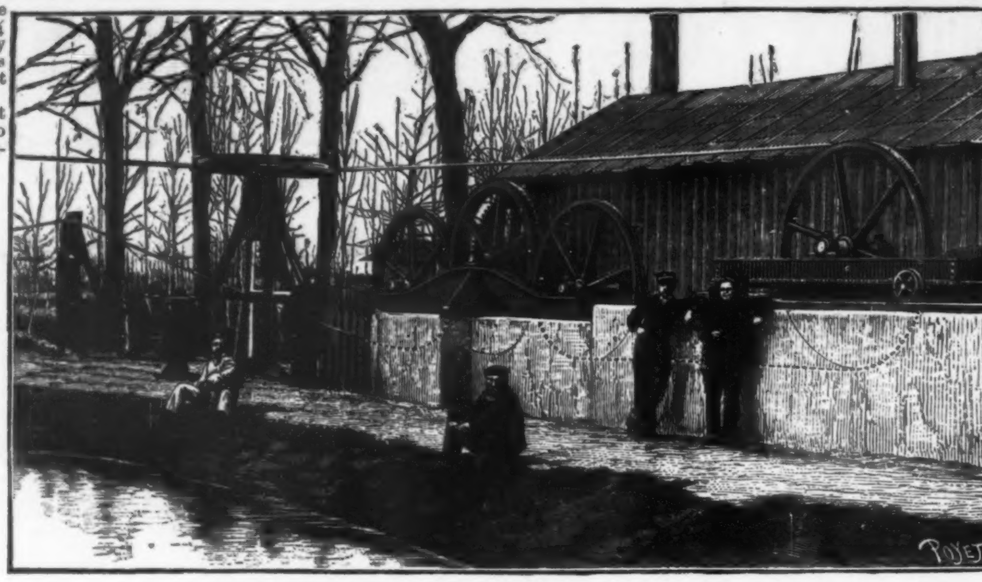


CANAL BOAT TOWAGE BY ELEVATED CABLES—A CANAL JUNCTION.

the tow line, which at once disengages itself from the link. The cable is given a velocity of but about 2¼ miles an hour, such velocity, in fact, being limited by the section of the canal and the length of the reaches between locks. It is, nevertheless, nearly double that obtained through hauling by horses.

The experiments just spoken of were undertaken at the instance of Mr. Guillain, director of navigation to the Minister of Public Works. Mr. Levy had as a colaborer his engineer, Mr. Pavie.

LOOP FOR ATTACHING BOAT ROPE TO CABLE.



DRIVING MECHANISM FOR OPERATING THE BOAT CABLE.

This first experiment, made upon a length of about 1,500 feet, has given good results. Mr. Delurs-Montand, Minister of Public Works, has just authorized Mr. Levy to apply his system on a length of three miles, and there is every reason to hope that, from a practical and economical point of view, this new experiment will be entirely conclusive.—*L'Illustration.*

THE AMERICAN INSTITUTE OF MINING ENGINEERS.

A CORRESPONDENT of *Engineering* gives an interesting account of the excursions of the members and some of the papers at the late meeting of mining engineers at Buffalo, from which we take the following:

NIAGARA FALLS.

Professor Pohlman read a paper entitled "The Life History of Niagara Falls." This paper was of semi-geological character, its author tracing the course of the great lakes from the time they were immense valleys emptying their waters through the Mohawk into the Hudson River. Professor Pohlman seemed to consider the whirlpool a more interesting phenomenon than the falls, for there the river had cut its way through the solid rock. The old Tonawanda River, and all others of this vicinity, had three falls, one of the Niagara limestone, one of the Clinton limestone, and one over the Medina sandstone. These were connected by rapids. In the whirlpool were confined the 20,000,000 cubic feet of water which fall over the cataract every minute, and the space was but a little over 400 ft. across. At one time it drained possibly into the Mississippi, and then into the St. Lawrence. Lake Ontario lowered down, and the cut took place at Niagara, for Lake Erie was looking for an outlet. There was no time to separate into the old channels, and at Lewiston there was a great depth of clay and shale, and there the cut was made. At the railway suspension bridge the first fall began, and not at Lewiston, as many supposed. There was the first embankment found heavy enough to hold a river. To come from Lewiston would have taken at least 200,000 years. The first historical picture was given by Father Hennepin in 1678, and he said the fall was 600 ft., and that such a fall did not exist anywhere else. Then the Horseshoe was not so far away from the American fall as now. The American fall, too, used to be in the shape of a horseshoe. From 1841 to 1886 the Horseshoe Fall went back 485 ft., and it was now going back about 9 ft. a year. The water on the brink was 20 ft. deep, and it might be that Father Hennepin was not so very wrong after all. He criticised the idea of a tunnel to the Niagara River below the falls to transport the power to Buffalo, saying this would require the walking of 16 miles of shale. The upper rapids fell 50 ft. in half a mile. The formation was the Niagara limestone; above this there was nothing but shale, and the river would cut through it, forming a rapid.

Excursions were made to the "grain elevators," the breakwater and other objects of interest around Buffalo. The rain prevented the carrying out of this part of the programme, although with admirable forethought one local paper published a full account of it in detail. The best the writer can do is to annex an engraving of the grain elevators we would have visited if the weather had permitted. The first was built in 1843 and had a capacity of 55,000 bushels. At the present time there are twenty-two of these stores, with a capacity of 9,215,000 bushels. In 1880, 98,902,050 bushels were handled here.

That afternoon the party went to the pumping station and saw a new Gaskill engine in course of erection. From here we went by the Belt railway to the Buffalo Cement Works. Borings in this vicinity have developed natural gas in sufficient quantities for the use of the works, and the exploration is still being continued.

The party were received in most hospitable shape in a large warehouse heated by an open grate of natural gas, where they were invited to a bounteous lunch; after this they were in a situation to fully appreciate the work shown them. The fossils found in the strata are of considerable geological interest. The formation is an impure limestone mixed with clay, and requires nothing but grinding and barreling to make it ready for the market. The grinding is performed by Carr disintegrators, and is very successfully done. The general character of the rock is similar to that used in making Portland cement, and it is said the Buffalo cement is the stronger of the two; the analysis is as follows:

	Portland.	Buffalo.
Silicic acid..................	31·43	32·86
Alumina	10·80	10·40
Lime and magnesia	56·77	56·74

On leaving the cement works the party were conveyed in carriages over the Barber asphalt pavement, and then by way of a painful contrast were driven over a few streets paved in the usual American manner. On arriving at the asphalt works we were shown the plant, and then witnessed the laying of a section of a street, which was certainly quickly and neatly done, exciting considerable favorable comment.

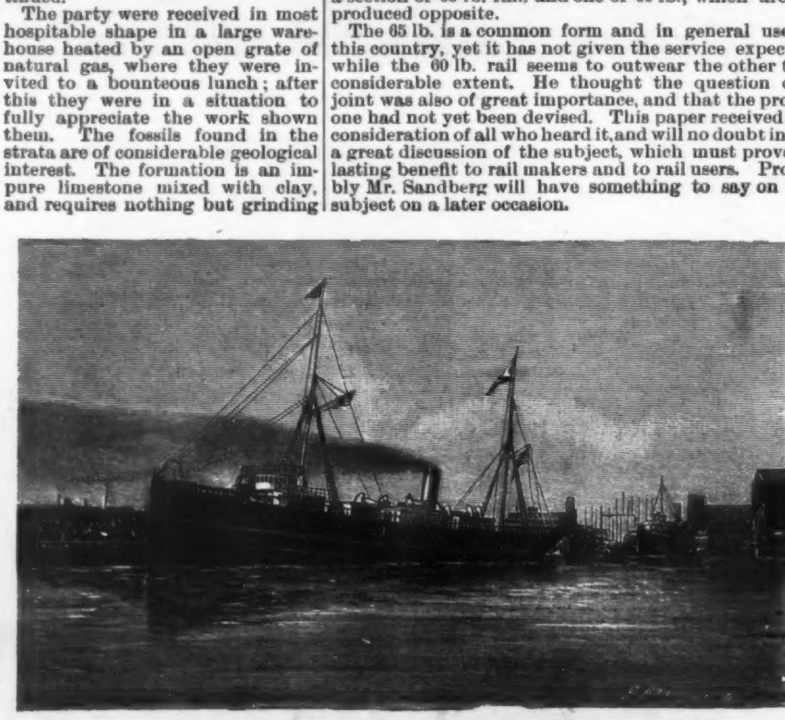
STEEL RAILS.

Mr. R. W. Hunt read an interesting and instructive paper entitled "Steel Rails." Coming from one so well known, and whose experience in this particular has been so great, the paper attracted much interest, and it will be discussed no doubt in the future. His conclusions were that the heavy sections so common in England, and which have been gaining in favor here, have proved a disappointment so far as durability was concerned. This however he attributed rather to a faulty design. The increased weight was attained by a greater depth of metal in the head, and this he thought unwise. As an instance he cited the cases of a 65 lb. rail and a 60 lb. rail of identical pattern except that the additional weight in the former was in the top, and it appeared on trial the 60 lb. rail gave better results. He thought the rails should be straightened as much as possible when hot, and condemned the application of a "gag" to the flanges. Harder steel should be used for the heavy rails, and ingots ought not to be turned on their sides until their interior is entirely chilled, as they are more liable to develop crevices lengthwise.

It seems that the first steel rails used in the United States were imported by the Pennsylvania Railroad from England, and the first rolled here were made at the North Chicago rolling mills in 1865. He gave then a section of 65 lb. rail, and one of 60 lb., which are reproduced opposite.

The 65 lb. is a common form and in general use in this country, yet it has not given the service expected, while the 60 lb. rail seems to outwear the other to a considerable extent. He thought the question of a joint was also of great importance, and that the proper one had not yet been devised. This paper received the consideration of all who heard it, and will no doubt incite a great discussion of the subject, which must prove of lasting benefit to rail makers and to rail users. Probably Mr. Sandberg will have something to say on the subject on a later occasion.

THE CITY HALL, BUFFALO.

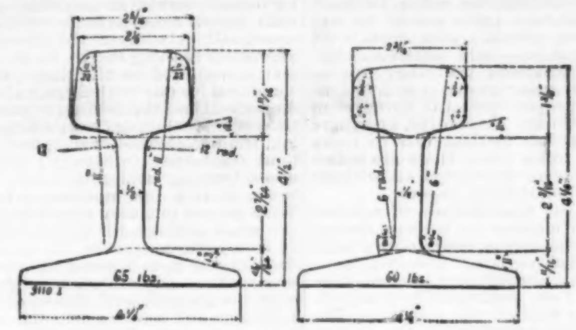


AN AMERICAN LAKE STEAMER.

ELECTRICAL TRANSMISSION OF POWER.

Mr. R. P. Rothwell followed with a paper on "Electrical Transmission of Power in Mining," the first application of which was made in New Zealand to drive a stamp mill. In Aspen, Col., water power has been transmitted to the mines, to the pumping and hoisting machinery, and also to the machinery at the coke ovens. A large installation is now being put in at the Nevada mill on the Comstock lode, water being taken to the level of the Sutro tunnel, giving a 1,680 ft. head, which

drives six 40 in. Pelton wheels, each of 135 horse-power, driving the dynamos direct. The Brush Electric Co. have provided the dynamos, each of 135 horse-power, and six electric motors, each of 90 horse-power, which are to drive the machinery of the Nevada mill. The longest transmission thus far has been on the Feather

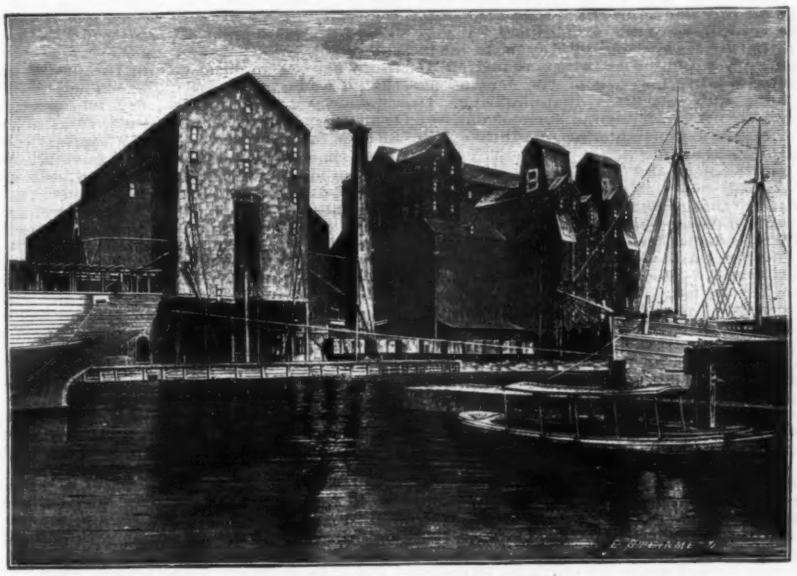


AMERICAN STANDARD RAIL SECTIONS.

River in California, the circuit being about 18 miles. In Alaska the water power on the mainland is to be used to drive 240 stamps, of the famous Treadwell mine.

LOCKPORT.

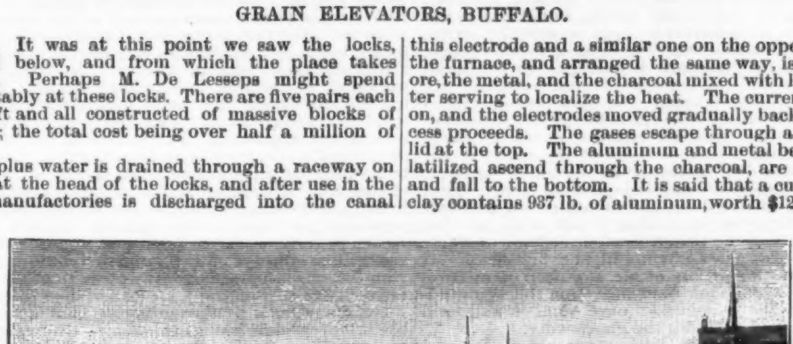
That afternoon we started for Lockport to visit the Holly Manufactory, where we saw a Gaskill engine in process of construction, and also admired the magnificent traveling cranes made by the Yale and Frome



GRAIN ELEVATORS, BUFFALO.

Company. It was at this point we saw the locks, illustrated below, and from which the place takes its name. Perhaps M. De Lesseps might spend time profitably at these locks. There are five pairs each of 12 ft. lift and all constructed of massive blocks of limestone; the total cost being over half a million of dollars.

The surplus water is drained through a raceway on one side at the head of the locks, and after use in the various manufactories is discharged into the canal



LOCKPORT.

below. On the other side it is drawn through a tunnel 1,000 ft. long cut in solid rock and runs under the Holly Works above noted, and which may be seen on a cliff above the locks.

COWLES ELECTRIC SMELTING WORKS.

From the Holly Works we visited the Cowles Electric Smelting and Aluminum Company. The two largest dynamos in the United States are here, developing 150,000 watts each, working all day and night without unduly pushing them; the power is furnished by turbine wheels. The ore used is corundum, and comes from North Carolina. It takes about 3½ lb. of ore to produce 1 lb. of aluminum alloy (Al_2O_3). The product amounts to 12 lb. of aluminum to each run of two hours. The process has been described in *Engineering*, so we may state in general that the furnaces are rectangular pits into which a cast iron pipe is placed at an angle; within this pipe projects a copper bar connected with the dynamo; at the opposite end of this bar is an electrode consisting of a bundle of carbons on which is a cylindrical head of metal (iron for ferro-aluminum and copper for aluminum bronze). Between the end of this electrode and a similar one on the opposite side of the furnace, and arranged the same way, is placed the ore, the metal, and the charcoal mixed with lime, the latter serving to localize the heat. The current is turned on, and the electrodes moved gradually back as the process proceeds. The gases escape through a perforated lid at the top. The aluminum and metal becoming volatilized ascend through the charcoal, are condensed, and fall to the bottom. It is said that a cubic yard of clay contains 937 lb. of aluminum, worth $12 per pound. The metal is there, perhaps, but how is it to be extracted? This is what the Cowles company propose to do, although not employing clay for that purpose.

INDURATED FIBER.

A few of the party having heard of the Indurated Fiber Company, and knowing their works were adjacent, asked the gentleman who was showing us around about them. He, by a strange coincidence, proved to be the owner, and on our expressing a wish to see them, he said he thought the party looked entirely too bright to go through his works; that he had spent a great many nights in thinking out the process, and did not propose to be "done" out of it. We promised to be stupid, and to take away nothing but a pleasant recollection of him, and he then agreed that we should go. The process was extremely interesting, and consists in the main of the following; that is, it was so stated, but our genial host was too smart to take us continuously through from one step to another, but this is the impression your correspondent received. The wood comes in the shape of a tree, and is pressed against a rapidly turning grindstone and ground into a pulp which mingles with the water, and is caught, washed, and run through rollers until it comes out a large sheet of wood pulp. This is then put into a shaper, which is, for instance, the shape of a wash tub, and is of brass with perforations. Over this is a form also of perforated brass corresponding with it. The sheet is put around the lower form, and by hydraulic pressure this is forced into the upper one, the result being a soft tub of wood pulp; it then goes into the drying-room, and after becoming dry is finished off smooth by means of emery and sand paper. It is also trimmed and finished up, thence it is dipped into a solution which gives it a polish and renders it impervious to water. This was what we were allowed to see, but there were gaps in the process we never saw, and could but smile when our host said we now knew all he did. The uses to which this "indurated fiber" are put are many—all sorts of utensils used in housekeeping, such as pans, pails, cuspidores, wash-basins, and in fact anything which does not go near fire. Insulators for telegraph wires were also being made here, and were giving satisfaction. The owner stated they were making a pipe for the underground conduits, and the advantages appear to be great. It is practically indestructible, very light, a non-conductor, and can be bent into any desired shape. It was further said the pipe so made would stand a pressure of 300 lb. to the square inch. Altogether, the party were pleased with their visit and returned to Buffalo well satisfied.

THE SALT MINE.

That evening there were a few more papers, and then came our final "wind-up" of good resolutions, that is, complimentary ones to our hosts and thanks for our entertainment. The party started the next day in a pouring rain to visit a salt mine. This is believed to be the only one in America, and is located at Piffards, a station near Buffalo. The party descended 1,100 ft. into the lower parts of the earth and saw two veins of rock salt, one of 20 ft. in thickness and one of 60 ft. The chamber is 70 ft. wide, cut out of solid salt, and extends about a quarter of a mile, with cross galleries and railroad tracks in them. The mule stables have walls of solid salt, which ought to be satisfactory to the occupants. The salt is blasted by dynamite, and comes out in huge blocks. The output is 1,000 to 2,000 tons per day. It has considerable use on the ranches, where a huge block is placed in a position accessible to the cattle. The salt is represented as 99$\frac{85}{100}$ pure, and contains no sulphur. The two other principal salt mines of the world are the great one at Cracow, in Poland, and the government mine in Germany.

As all our salt has to be obtained from brine by evaporation, the advantages of rock salt are at once apparent. The writer has a keen appreciation of salt wells, having passed many weary hours on the Ohio River among them. There the coal is in the hills and the salt wells are at the foot, and yet they can't make money. The finer grades of salt go through the evaporating process several times before ready for the market. As a recommendation for this company's product, it may be said that a manufacturing company at the salt wells prefers to send here for rock salt rather than use that at their doors, and are taking 50 tons daily. A fine lunch completed our programme, and ended a most enjoyable and instructive meeting.

It only remains to chronicle a list of the papers presented, many of which were read by title and were therefore not burdensome to the listeners. "The Uses of Asphalt," Captain F. V. Greene, New York, vice-president of the Barber Company; "The Glenmore Iron Estate, Greenbriar County, Virginia," W. N. Page, Powellton, West Va.; "Anthracite and Coke, Separate and Mixed, in the Warwick Blast Furnace," Edgar S. Cook, Pottstown, Pa.; "Note on a Tuyere Slagging Valve," Edgar S. Cook, Pottstown, Pa.; "Note on a Speed and Pressure Regulator for Blast Furnace Engines," Edgar S. Cook, Pottstown, Pa.; "Chlorination at the Phœnix and Yadkin Gold Mines, North Carolina," William B. Phillips, Chapel Hill, N. C.; "A Differential Hot Blast Stove, and its Application to an Open Hearth Blast Furnace," Jacob T. Wainwright, Pittsburg, Pa.; "Note on a Specimen of Gilsonite from Uintah County, Utah," R. W. Raymond, New York; "Soaping Geysers," R. W. Raymond, New York; "Note on a Gold Breastplate from Central America," Dr. R. W. Raymond, New York; "Notes on the Roasting of the Hudson River Carbonate Ores," Ingersol Olmstead, Burden, New York; "The Minerals of Ontario and their Development," W. Hamilton Merritt, Toronto; "Note on a Cast Steel Water Jacket," R. H. Terhune, Salt Lake City, Utah; "The Flue Dust of the Furnaces at Low Moor," Ellison C. Means, Low Moor, Va.; "Notes on the Rosario Mine, San Juancito, Honduras," Thomas H. Leggett, Fairplay, Col.; "Steel Rails," R. W. Hunt, Chicago; "Water Analysis," A. E. Hunt and George H. Clapp, Pittsburg; "The Electrical Transmission of Power in Mining," R. P. Rothwell, New York; "An Attempt to Fuse Carbon, and its Bearing on the Genesis of the Diamond," Alfred H. Cowles, Lockport, New York, and George F. Kunz, New York; "The Handling of Natural Gas," J. F. Wilcox, Pittsburg; "Forestry and Mining," B. E. Fernow, Washington, D. C.; "Pig Iron of Unusual Strength," Fred. P. Dewey, Washington; "Nickel Ore from Logan Co., Kansas," F. P. Dewey, Washington; "The Life History of Niagara Falls," Julius Pohlman, Buffalo; "Cement Rock and Gypsum Deposits in Buffalo," Julius Pohlman, Buffalo; "Improved Methods of Refining the Oils of the Findlay Field of Ohio," Professor W. H. Pitt, of the Buffalo High School; "Notes on the Artificial Propagation of Mushrooms in the Abandoned Quarries of the Akron Cement Company at Akron," Uriah Cummings, Buffalo.

AN EXPERIMENTAL LECTURE ON FLAME AND SMOKE.*

By THOS. FLETCHER, F.C.S.

I HAVE here an ordinary type of regenerator burner for lighting purposes, which, under ordinary and satisfactory conditions, gives a clear light without the formation of any solid or offensive products of combustion. If the gas supply is increased slightly beyond the quantity the lamp is designed to burn, we obtain a large quantity of dense, black smoke. Now, this smoke is simply pure carbon. It has no more objectionable features than ordinary fine dust, except that it is more visible on account of its color; and owing to its extreme fineness, it is rather more difficult to remove with a duster. It is perfectly free from smell; and is no more objectionable in a room than a similar quantity of dark dust. I have been quietly working in a room with a regenerator lamp which suddenly began to smoke, without perceiving any change whatever, until the light appeared to fail. On looking up, I found the room filled with dense, black smoke; the effect other ways being quite inappreciable.

This is one of many illustrations which could be given that pure black smoke is, apart from its color, for all practical purposes unobjectionable. We will now take the other side, and see what may accompany black smoke, or what without smoke may arise from imperfect combustion; and for the sake of fair illustration, I will take the same fuel—*i. e.*, coal gas—and change the conditions under which it is burned. Those who which to test this matter at home may do it in several ways. If only an ordinary lighting burner is available, it will be sufficient to suspend in the flame by a wire a rather large block of pumicestone. If this be placed low enough to break up the form of the flame, it will cause imperfect combustion and the formation not only of black smoke, but also of carbon monoxide (which is a poisonous gas) and some most offensive smelling hydrocarbon compounds. A still more powerful demonstration may be made by an ordinary atmospheric boiling burner, which, when properly lighted, gives a clear, blue, smokeless flame, free from any objectionable odor. If a light is applied inside the tube, the combustion becomes imperfect, and the products are similar to those in the previous experiment, but much larger in quantity; in fact, with the burner I have here, I could render the air of this room most offensive in a short time, with the result that probably more than half the audience would leave the room with a severe headache, although the actual smoke produced would be much less than that given off by the regenerator burner. Another familiar instance is that of a common tallow candle, which, if burning with a smoky flame, simply causes what may be called mechanical smoke. But blow the candle out and let the wick smoulder; and from this little speck of red will be evolved a smell which is anything but pleasant, and this with an entire absence of smoke. Here, then, is the difference between the comparatively innocent but much abused smoke and the invisible but offensive noxious vapors. If the latter can be efficiently dealt with, the former will at the same time almost disappear. I do not wish you to think I have any desire to speak in favor of smoke, but simply that it shall be credited with its own evils only.

Black smoke is very objectionable, as is any other form of mechanical dirt; and it should therefore be avoided. But we must bear in mind that legislation on this matter is a very difficult thing; and it is quite possible to "jump out of the frying-pan into the fire," by stopping smoke, and causing in its place the production of carbon monoxide and other poisonous and offensive compounds of carbon. There is a good deal of truth in the remarks of an old gardener of my acquaintance, who had worked in the same place for some thirty years, that before smoke-consuming furnaces were used his plants got dirty, but since the manufacturers on the windward side had commenced to consume their smoke, they did not dirty his plants, but only killed them. The smoke was replaced by vapors which killed his plants and ruined his garden.

First among the evils is the sulphur which is contained in all ordinary coal. This is the most destructive, and the most unmanageable evil we have to contend with. It combines with the oxygen of the air, forming sulphurous or sulphuric acid; and this all-pervading nuisance can be detected instantly (by litmus test papers) in the air of any large town, on damp walls, in the gutters, and, in fact, everywhere. So universal is this powerful acid, that I have hunted London over in winter to obtain a book of blue litmus test paper which had not been colored red by the sulphur in the air, and failed to obtain it. A book was sent to me direct from the makers in a corked and sealed glass bottle. This I opened while in a carriage on the underground railway, and in a few seconds the paper turned a bright red. I tested the mud in the street, the damp on bricks and carved stone, the moisture on the trunks and leaves of trees in the parks; and the result explained the rapid destruction of stone carving, metal, and everything which could be destroyed by dilute acids. There is, I believe, only one remedy, or rather one method, of reducing the evil, and that is by reducing the total coal consumption in the country; and there is hope in this because a reduction in coal consumption means a saving of money. It is useless to talk about the reduction of smoke, or of noxious vapors, unless we can show the offenders very clearly that a profit is to be made by their prevention. All methods of fuel saving are steps in the right direction —provided, of course, the production of noxious vapors is not increased, as it certainly may be under some circumstances.

Take, for instance, some gas engines. Their great economy in fuel is undoubted; but note the care with which the users lead the burnt gases outside, for the benefit or otherwise of their neighbors. The poisonous stench evolved by some of them is not easily forgotten if once encountered; and this serious question has been quietly ignored by the makers of gas engines, who have the commercial tact to know that if their customers get the power, it is a matter of indifference who gets the stench evolved. As regards sulphur, gas engines are a great improvement. In the first place, the quantity of fuel used is very much less for the same power, and the gas is almost entirely free from sulphur. But really perfect combustion is difficult if not impossible in a heavy metal cylinder, and it is probable that the gas engine of the future will be very different to the present type. That coal gas can be burnt without nuisance we all know, otherwise it would not exist for lighting purposes. That it can be made offensive I have shown you, and, therefore, it would not be unfair to insist that all gas engines should, to a great extent, be free from the objection which certainly now exists with many of them. With regard to steam boilers and furnaces, there is no doubt whatever that they can be made smokeless, either by using gas coke as a fuel, as we ourselves do, or by a proper system of firing, such as may be seen on any ordinary locomotive, and there is no doubt, also, that either method can be made profitable. But, on the other hand, there are industries which apparently cannot be carried on without the production of smoke and noxious vapors.

As an instance of this, the manufacture of puddled iron may be taken, which requires to be kept during the whole process in an atmosphere containing a large proportion of uncombined carbon. Possibly, as a total, the greatest offenders are ordinary kitchen chimneys, and in this opinion I am confirmed by many observers who have closely studied the question. The fire is more or less surrounded with metal, the cooling effect of which prevents perfect combustion in its vicinity, and the same objection exists to a greater or less extent with all fire grates which are not entirely lined with fire clay. It is only necessary to look over a closely built town or village on a clear, bright morning to see where a very large proportion of the nuisance arises, or to visit a hilly district, where we can get above the level of a number of ordinary house chimneys, to appreciate the very unpleasant nature of the products of imperfect combustion which arise, and which always must arise, from slow and imperfect combustion. But the tide in favor of the use of coal gas for ordinary domestic heating and cooking purposes has set in so persistently and on so large a scale that what has been already done must have a decided effect on the general cleanliness of the atmosphere. It may safely be said that coal gas is not by any means at its lowest ultimate price, and that every reduction in price will cause a large increase in the demand for heating purposes and uses other than lighting. In this respect we are decidedly behind some of our own colonies. For instance, in Melbourne one-third of the total gas made is used during daylight.

There are many points and peculiarities about the combustion of coal gas which are little known; and there are yet many things which remain to be discovered. One important point, which is usually overlooked, is that the size of a flame has nothing whatever to do either with the gas consumption or with the amount of work which can be obtained from it; and I will give you some illustration of this with different burners, each consuming approximately the same quantity of gas. In the first place, I will take a quantity of gas unmixed with air, and burning on a broad surface of gauze. I must apologize for introducing what is now an old experiment; but it is necessary to illustrate the subject properly. The flame obtained is large and luminous, but as a heating agent it is almost useless; as, if we place any vessel over it, a deposit of carbon would take place (as you see), preventing the passage of heat to the vessel. If I mix a small quantity of air with the gas, the flame increases in bulk, but not in temperature; in fact, there is only an outer film of flame, which is very deceptive in appearance. I can prove that the flame is cold in the center, by protecting my hand from the outer film of flame, and putting my bare finger inside it; and again, by putting a parcel of gunpowder inside, which, as you see, remains unburnt. Not only does no flame exist inside, but flame is not even possible; as a burning paper is actually extinguished, and I cannot carry a light into the flame. The fact is that a mixture of coal gas with a small quantity of air will neither explode nor burn, nor will it even support combustion; the flame being caused and supported entirely by the external air surrounding it. That the unburnt mixture exists is easily proved by leading a part of it out of the center of the flame by a tube, and igniting it at the top of the tube, thus forming a separate and independent flame. That this flame is also hollow, and contains an unburnt mixture, I will prove by leading it out with another smaller tube; making thus a third independent flame from the unburnt gases existing in the first flame. If I increase the proportion of air, I obtain a mixture which will burn without assistance from the surrounding air; the flame becomes at once smaller and solid to the center, and explodes the gunpowder.

It is possible to produce, with another fuel—*i. e.*, ordinary proof spirit—a much colder flame than can be obtained with coal gas. This I will show you, by saturating a cotton handkerchief and setting fire to it. The flame, although large and important-looking, is so cold that it has not the power even to scorch the handkerchief, which comes out of the trial unharmed. We will test this flame further, and take a ball of explosive gun cotton, saturate it with the spirit, and set it on fire. As you see, the spirit burns away without having the power to ignite the gun cotton.

Returning to gas, I will now burn the same quantity as before, in a blowpipe supplied with air under pressure. You see that the flame is again greatly reduced in size; and you can at once judge of the greater intensity of the heat evolved by the ease with which I fuse this mass of iron wire.

In using gas and air as a fuel, we have always to contend with the inert nitrogen which forms four-fifths of the bulk of the ordinary atmosphere. A simple and cheap method of removing this nitrogen is now being worked by the Brin Oxygen Company; and carrying out experiments to the highest limits yet attained in practice, I will show you the same quantity of gas burning with air under pressure, from which this nitrogen has been removed by the Brin process—nearly pure oxygen alone being left. Note, again, that the flame is much smaller even than before; but this aggressively noisy little flame is a power before which few things will stand. Thick copper plates flow before it like water; strong steel boiler plate is fused and perforated in less than a minute; refractory fire-clay is fused into a glass; and a block of lime—one of the most refractory and infusible substances in nature —although it will not fuse, emits a light of blinding intensity, which gives a fair idea of the actual heat of this insignificant-looking flame.

In flames, as in many other things, we must not judge by appearances, but only by results; and my experiments have very clearly proved that in coal gas we have a source of heat at command which is capable of filling all requirements, and has the special advantages —which are peculiar to itself—of being cleanly, ready for instant service at any time, capable of being used with proper arrangements without the slightest nuisance, and (what is of the utmost importance) costing absolutely nothing except in direct proportion to the service required at the time. We have here a fuel at command for our workshops and our houses which will do perfectly all the heating required in ordinary domestic service, including fires, cooking, bath heating, washing, ironing, clothes drying, and at the same time will light our houses brilliantly; while, for workshop purposes, brazing, soldering, small furnaces, and other work, it is a fuel unequaled by any other known. With proper but very simple arrangements, it will do the whole of this work without any nuisance whatever. In fact, both as regards the inside of the building and the outside, it is beyond all comparison cleaner and sweeter than any other known fuel; and it does away with the greatest evil, the sulphur which destroys our buildings and metal work, and renders the air of any large town so offensive—this result being attained partly by the greatly reduced quantity of fuel necessary when coal gas is used, but principally by the removal of sulphur from the gas in the process of manufacture.

That failures occur occasionally in the application of coal gas to domestic and workshop purposes can only be expected so long as its application is so comparatively recent. But these failures are very rare; and they may be set down to the want of experience in the men who have the responsibility of fixing the apparatus, and also to want of practical acquaintance with the nature of the fuel on the part of the users. The knowledge of what is required is now becoming pretty general; and the failures and difficulties are very rare indeed.

My own house and works are, and have been, practically smokeless from the time they were built; and this result has been obtained from the first at a lower cost than if we had used coal. We will allow that no radical change must be made if general success is to be obtained; and taking as a necessary evil the fact that the kitchen fire is in many houses a necessity in winter for other than cooking purposes, we have allowed it to remain in my own house instead of entirely removing it, as was originally intended. It is burning, probably, for about half of each day during about five months in winter. We tried gas coke; but, like many others who have tried it, we gave it up as a failure, owing to several inherent objections to it in practice. In its place we now use a mixture of coal and coke; the fire obtained being brighter, cheaper, and cleaner than when coal alone is used. In the hothouse and conservatories we use coke exclusively; and these are the only fires burning solid fuel. For our cooking, washing, ironing, bath heating, and other fires, we use coal gas exclusively. By this arrangement we not only save money, but we carry out in practice the desires of the Noxious Vapors Abatement Association, by using a much smaller quantity of a purer fuel; and, what is of still greater importance to the small householder, the dirt and labor in the house are reduced to less than one-half. So great is the saving that the expenditure on the necessary appliances for the complete service of an ordinary house would nearly or quite be repaid in the first year by saving in cost of labor and wear and tear alone.

Let it be distinctly borne in mind that I do not come before you as a special pleader for the use of gas as a fuel because I am a manufacturer of the necessary appliances. The fact is that for more than ten years before I made any appliances for sale for domestic use, I had the same fuel in daily use for every purpose for which it could be economically applied; and during the last twenty-five years I have made no change whatever, except in adopting more modern and more economical apparatus. Further than this, the whole of the appliances have been from the first and are now being used in an ordinary house designed for the use of coal fuel. Absolutely no alterations have been made in fittings or arrangements, except as regards laying the necessary gas pipes where required. In fact, we could return to the complete use of coal, to the exclusion of gas, at five minutes' notice; and we could remove the whole of our apparatus to any other house with equal facility.

I will now, as a final experiment, heat a small crucible full of broken steel files with the blowpipe previously used, and will fuse both crucible and steel—showing you the enormous power of the fuel we have at instant command; the actual weight of fuel used in this experiment being about 1 oz. Those of you who have had to deal with the production of high temperatures by the use of solid fuel will fully appreciate the value of the servant you have at hand, night or day, at any moment, in every place in which coal gas is to be obtained. In the household we may take an equally representative case as a bedroom fire. Who among you has not desired that practically unattainable luxury, in the absence of gas, a good bedroom fire every night and morning? And yet this can be obtained with gas without the slightest trouble for less than ½d. per day. The people who would go out of a warm sitting room to undress in a cold bedroom, for the sake of saving ½d., are few and far between. The value of coal gas for this and endless other purposes requires no special pleading; it simply requires to be known, and the necessary information is spreading rapidly. As the knowledge of its value spreads, so will the demand for all purposes.

* Abstract from a recent lecture delivered before the Manchester Noxious Vapors Abatement Association.

BOOKBINDING.

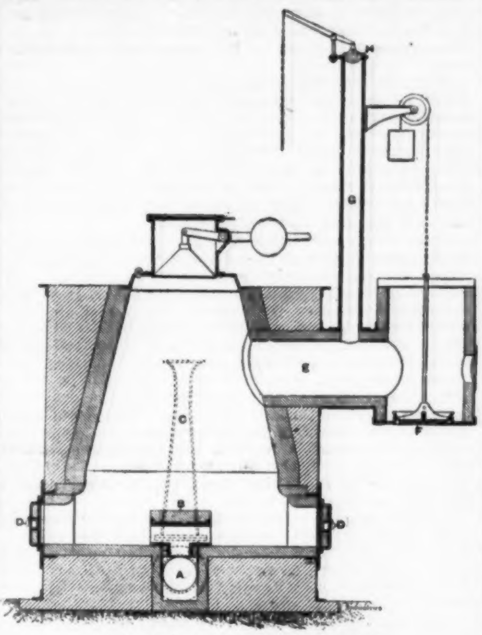
AN interesting lecture on "Bookbinding" was recently delivered by Mr. Cobden Sanderson, before a crowded audience, at the Arts and Crafts Exhibition, Regent Street, London.

The lecturer commenced by saying: "The beginning of art was not itself a comparatively simple matter; much was usually described, but it depended upon great and interesting conditions of society and its higher rises into admiration by such ways of expressions as were within reach. It was his purpose that night to demonstrate how a book was bound, the spirit in which it should be bound, and the aim of the binder

of the higher kind; and in conclusion to touch upon the purpose of these lectures and the interpretation to be put upon the class of handicrafts in general he must advert to, and if possible to give explanation to his subject and higher matters of thought and craft constituting the art of the bookbinder. He would first ask them to think of man—of the scientific universe partly created by him and his reduction of these thoughts to expression, and his desire to give them prominence. That desire originated the binder's craft. The lecturer next dealt with the history of his subject. It was palpable that the art was an ancient one, and one which must have assumed many strange forms. The Roman was the earliest part of literature; the different sheets were sewn together, unrolled, and rolled up again. In the Roman style the binding was a very elaborate affair. A spare sheet was attached at the end of the book; the upper margins were cut perfectly even, and the sheets were smoothed with pumice-stone and the gather was fastened to a cylinder. Sometimes the cylinder was constructed of bone. The boards were generally made of bone, and were found carved and adorned with precious stones; two strings, sometimes of colored ribbon, were attached to the last sheet or gather of the volume. The book was protected by being inclosed in cases of cedar. It would be interesting from this point to trace the history of binding and its variations up to the present time, and to speculate upon the introduction of different materials. Unlike the previous lecturer (Mr. Walker), he could not provide an illustration, but he would request his hearers to exert their own powers of memory and imagination, and to perform the work of illustration themselves. He would recall the names of the old binders, and among them the famous King of Hungary, whose library contained upward of fifty thousand volumes and manuscripts, all in the most costly binding, too costly as event turned out, for they were seized by the invading Turks." The lecturer then mentioned the names of a few of the great binders, such as Le Gascon, and some of the patrons of bookbinding, like the Medicis, Grolier and the wonderful women who so loved books that they lent them some of the perfume and grace of their own strange lives. He further said: There were innumerable branches of industry upon which the binder's craft depended for the production of materials and tools. The modern binder used many materials, threads of flax, colored paper, boards, cloths, skins of all kinds. Ancient binders used good skins; those of wild animals were the best. In these latter days they had to be contented with skins obtained from the wilds of Africa, which did not always come up to the wishes of the binder. There were two classes of binding, one for use and the other for beauty. He did not mean to convey that the useful might not also be beautiful, and the beautiful useful. One class might be characterized as having use for its end, and the other having beauty. Books classed under the first denomination were, for instance, like those issued in France in the paper covers. Such books were only for temporary use. Commenting on the subject of decoration, the lecturer said the galleries of the exhibition contained many admirable specimens of decoration. He condemned the practice of decorating books with so flimsy a binding as cloth. Such binding speedily decayed, and he knew nothing more pitiable than to subject beautiful designs to such indignities. Bindings should adopt the form of homage to good books. Morocco he considered the most superior material—calf was prone to wear out soon. He would explain to them how he should proceed to bind a book, and although strongly averse to the introduction of the personal element, as he was so little of an artist, if it were true that he was young at the craft, he was old in all its thoughts and forms. The lecturer having divested himself of his coat, amid laughter, and donned an apron, remarking that the apron was the banner of the future, proceeded to give practical demonstrations of bookbinding throughout all its stages. Hand-made paper should not be hammered as other paper was—it deprived it of all its "animation." Rough edges, he was of opinion, bespoke affectation—a book should present a neat appearance. He expressed his preference for concave backs, and exhibited the benefits from this mode, inasmuch as it increased the flexibleness of the book. Of course, this did not apply to large books, whose heaviness gave them the necessary weight. In his concluding remarks, the lecturer said: As for beautiful bindings, in them decoration rises into enthusiasm, and beautiful binding is a homage to genius. It has its ethical value, its spiritual effect. By doing good we raise life to a higher plane. A book is sensitive by nature. It is made by a human being for a human being, and the design must come from the man himself, and express the moods of his imagination, the joy of his soul. He would ask, What were the qualifications of the binder? He must be, in the highest sense of the word, besides craftsman, an educated man. He must be conversant with the beautiful in literature to give adequate expression to his enthusiasm. In connection with the object of the lectures, he remarked that the happiness of a great people intellectually and morally depended, in the society's opinion, on this movement. The avowed intention of the society was to attract the attention of the educated as well as the attention of the working classes, in order to kindle in their minds a conception of delightful and honorable labor.

IMPROVED GAS PRODUCER.

THE Ingham gas producer, which we now illustrate, is designed to facilitate the operations of breaking up the clinkers and clearing away the ashes. It consists of a wrought iron casing, lined with fire brick, and has at the bottom a flue, A, over which is a central arch, B, of cast iron, lined with fire brick. The flue, in addition to forming a conduit for the air supplied for combustion, is also utilized as a temporary receptacle for a portion of the ashes, from which they are readily removed. The cleaning out process is, however, principally carried out by means of the doors, D D—which, from their positions, are kept cool, and are thus not liable to warp or twist—placed exactly opposite each other, and at right angles with the central arch, thus allowing of a bar or rake being passed right through the producer, by which means considerable facility is afforded to the attendant in the work of keeping the fire clean and open. In this the central arch also further assists, by taking the weight of superincumbent fuel. The charging of the producer is effected by means of the bell and hopper, sufficient coal being regularly supplied to keep the producer charged level with the gas outlet, E. The air for combustion is forced in by means of a steam jet at C, which, after passing through the central flue, A, gains admission into the producer through the space under the arch, B. The gas is taken off from the upper part of the producer, through the outlet, E, when it has obtained a slight pressure, and passing through the valve, F, is conveyed to the furnace or other appliances for which the gas is required. A safety valve, H, is provided, in

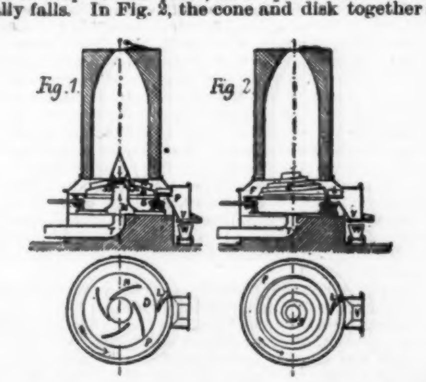


IMPROVED GAS PRODUCER.

conjunction with the separate outlet, G, which, if necessary, may be opened, and the gas ignited for illuminating purposes. We had recently an opportunity of seeing one of the Ingham gas producers at work, at Messrs. William Gray & Co.'s central shipbuilding yard, West Hartlepool, where it has been regularly employed during the greater part of this year in supplying gas to the plate and angle heating furnaces, and where it has given great satisfaction. Our illustration has been taken from this furnace, which is 7 ft. in diameter and 8 ft. 6 in. in height, and is calculated to gasify 4 cwt. of coal per hour, producing about 30,000 cubic feet of gas.—*Industries.*

IMPROVEMENTS IN LIMEKILNS.

THE improved kiln is closed at its lower part, and air necessary for combustion is forced in through the pipe, T. The walls of the kiln are made vertical, so as not to present any obstacle to the regular fall of the material. The discharging mechanism comprises a conical central part, M, resting on the ground. This central part is placed in the axis of the kiln for the purpose of moderating the descent of the lime by forcing it to spread itself on the circumference for leaving the kiln. Beneath the conical part is an annular disk or plate, D, mounted on rollers, G, upon which bears the charge of the kiln. The plate is provided with vertical ribs, N, running obliquely from the circumference toward the center. The plate being rotated mechanically, the effect of the rotation is to throw the lime over the whole of its periphery. The rotary plate carries an annular projection, P, forming a lower step to the plate, and upon which the lime finally falls. In Fig. 2, the cone and disk together are



replaced by a single spiral, S, forming a sort of continuous incline. The lime conveyed by the circular motion is stopped by a vertical blade, L, arranged obliquely to the radius of the disk, and is forced in the direction of the blade until it reaches the point where it is discharged through a sliding door, V, into wagonettes, W. The limestone is taken from the crushers and is charged in by an elevator at the top of the kiln as the lime is being discharged below. The kiln is thus entirely mechanical and continuous in its work.—*E. Solvay, Brussels.*

INFLUENCE OF WATER UPON WOOL.

As in the cases of the other textile fibers, wool, from the beginning of its treatment, even on the sheep, until the last finishing process, is more affected by water than by anything else with which it comes in contact. Water is made to act in two ways upon wool; it dissolves the substances necessary to be taken away, such as urine, salts, etc., and it replaces them with soaps, finishes, dyes, starch, etc., so that without water it would be impossible to clean and full the wool. Without water all these operations would be useless or different in their character, and often more injurious than beneficial.

Water, particularly at a high temperature, softens the fiber and makes it more supple, while, when it is absent—especially when the natural grease designed to accomplish the same purpose has been removed—the wool becomes stiff and harsh.

Without speaking of the washing of the wool, either on the sheep's back or in the factory, which of course requires water, the first operation to consider is the dyeing; for this purpose the quality of the water must be suitable for the dyer; in fact, soft and pure.

The spinning requires water to a less degree, and it is only used to dilute the oil in carding. After the weaving comes the fulling, and here the water plays an important part. By its action, together with that of soap and alkali, the projecting parts of the wool during fulling are freed from grease, and thus the fulling becomes possible. That the water penetrates to the interior of the fiber and softens it is a fact that has not always been admitted. Heat also plays an important part in fulling, for by its action the hard substance of the fiber is softened and the operation facilitated.

That water softens wool fibers can easily be shown in the following way: A piece of moist cloth can be more easily torn than a piece of dry cloth, and woolen cloth is so hygroscopic that it can retain 30 per cent. of its weight in water without being moist, or even damp. On the other hand, manufacturers admit that cloth which still retains some grease, which prevents water from penetrating it, will never felt as well as that from which this matter has been removed.

But if the presence of water aids in fulling, it is also injurious to the cloth if it is submitted too long to its action, for then the water stiffens it, and gives it a particular feel, which cannot always be removed in drying. If, on the other hand, the cloth has been well wrung, and not partly dried by a machine, and is then placed in a very warm stove, it takes on a brilliancy and is full to the touch, showing that the action of water is important in the finish.

In drying, the cloth is also influenced by the action of water, for if a wet piece of cloth is hung up to dry in the air, it will be observed that the lower part, toward which the water has run, will be harder to full than the upper part.

The action of water upon wool is not always the same, or, to speak more correctly, different kinds of wool are not equally affected by water. There are some wools which do not become flexible under the action of water; and even if very wet, do not fill out well, where others require only a small amount of moisture to take on a brilliant appearance, as in plush. In this regard the origin of the wool plays an important part. To the first class belong Cape wools and the coarser German wools, while Buenos Ayres, Sydney, and Port Philip wools belong to the second class.

The quality of the water is naturally of very great importance, for all the properties indicated below are to be found only in pure water. The water should be soft, and should not contain carbonate of lime nor other substances, while a hard water, such as is found commonly in mountain streams and wells, makes the operations difficult and unsatisfactory.—*Deutsche Wollengewerbe; Textile Record.*

COLOR SENSITIVE COLLODION EMULSION EQUAL IN RAPIDITY TO GELATINE PLATES.

IT will be understood that Albert's collodion emulsion contains the same modification of silver bromide as the ordinary well known collodion emulsion—that is to say, a white bromide of silver, sensitive to the violet and indigo rays of the spectrum.

In our first experiments we thought that Albert's emulsion (before being dyed) was somewhat more sensitive than the ordinary collodion emulsion. In order to settle this point positively, we prepared a fresh collodion emulsion made according to Warnerke's formula and compared it with that of Albert. We found that Albert's (undyed) emulsion was in nowise more sensitive than that made according to the before mentioned formula.

Further experiments were then made by dyeing the emulsion which we had prepared with Albert's portrait dye. It then showed precisely the same sensitiveness as Albert's dyed emulsion.

From these experiments it follows that there is no difference between Albert's emulsion in the undyed state and the collodion emulsion as hitherto well known. The novelty lies only in the color sensitizer. With regard to the latter it has been already stated that it contains erythrosin, but that silver could not be recognized therein by the accustomed test of hydrochloric acid. Close examination of the matter shows that eosin silver dissolved in dilute nitric acid only gives a precipitate with hydrochloric acid when there is a little nitrate of silver in excess; otherwise not.

Further trials with Albert's portrait dye solution gave results unmistakably like those obtained with a solution of eosin silver in ammonia. Both solutions showed, when carefully neutralized with nitric acid, a cloudiness, and precipitation of red erythrosin silver. Albert's color solution, however, proved to be in a more concentrated state than a saturated solution (about 1 in 1,000) of erythrosin in alcohol.

From various trials it was found that erythrosin is much more soluble in methyl alcohol than in ethyl alcohol, and that a solution of 1 part of erythrosin in 200 parts of methyl alcohol was more intense in color than Albert's solution. This solution (of erythrosin in methyl alcohol) was then added in the proportion of one to ten to the collodion emulsion, and tried. The color sensitiveness proved, however, to be but slight, and did not approach that of Albert's preparation.*

The dye solution was now mixed with an alcoholic solution of silver, and the precipitate redissolved in alcoholic ammonia. The solution thus obtained was added to ten times its amount of bromo-silver collodion emulsion. We thus obtained an emulsion which corresponded completely with Albert's portrait dye collodion

* Erythrosin in water and erythrosin silver dissolved in ammonia show the same spectrum, because erythrosin silver is decomposed by ammonia. On drying, as the ammonia evaporates, erythrosin silver is again formed.

both in color sensitiveness and in general sensitiveness. Addition of picric acid made not the slightest difference to it.

In order to make quite certain that we had reached the same result as Dr. Albert, we sensitized a portion of our emulsion with Dr. Albert's color solution and another portion with the solution we have described, and exposed plates prepared with these preparations simultaneously, and for a like length of exposure, to a color chart. The result was that in color, as well as in general sensitiveness, the two plates were identical.

From what has been said, there remains no doubt that Albert's color sensitive collodion emulsion (for portraits) consists for the one part of a collodion emulsion prepared in the customary way and for the other part of a very concentrated solution of erythrosin silver in methyl alcohol and ammonia, with some picric acid. The value of the picric acid remains undecided. To Dr. Albert, however, is due the credit of having first discovered the surprising sensitizing power of a very concentrated solution of eosin silver in ammonia. Without his example others would not so quickly have come upon the interesting fact that it is possible to prepare color sensitive collodion emulsion attaining the sensitiveness of gelatine emulsion. Dr. Albert has thereby opened a new road.

We give here the formula for an erythrosin silver dye solution:

A.—Erythrosin	0·5 gramme
Pure methyl alcohol	100 c. cm.
B.—Nitrate of silver	4 grammes
Warm water	4 c. cm.

After solution, add 96 c. cm. pure alcohol at 96°.

Ten c. cm. of A is mixed with 1 c. cm. of B and 4 c. cm. of alcohol (not aqueous) ammonia. This mixture will keep.

For use, 1 part of the solution is shaken up with 10 of bromide-silver collodion emulsion.

We have also experimented with Dr. Albert's "reproduction dye," which contains rose Bengal silver, but did not obtain the desired result.

As a developer, we employed hydrochinone with carbonate of soda and a few drops of solution of bromide of ammonia, according to the following formula:

1.—Hydrochinone	10 grammes
Sulphite of soda	50 "
Water	700 c. cm.
2.—Crystallized carbonate of soda	100 grammes
Water	800 c. cm.

Sixty c. cm. No. 1 are mixed with 10 c. cm. of No. 2, and two or three drops of a 10 per cent. solution of bromide of ammonia added thereto.

The only drawback to the process is that the plates are only useful in the wet condition. When dry they are twenty times less sensitive; and as dry plates, generally useless.—*Dr. H. W. Vogel, in Photographic News.*

PHOTOGRAPHIC ENGRAVING ON GLASS, AND OTHER APPLICATIONS OF FLUORINE IN PHOTOGRAPHY.

By P. C. DUCHOCHOIS.

FLUORINE, on account of its great affinity for all the metals to which it unites directly, and its destructive action on glass and porcelain, can be isolated only with the greatest difficulties. Fremy succeeded to effect its dissociation from potassium-fluoride by means of electricity. Prat seems also to have isolated it in employing a recipient of fluor-spar.

It is described as a gaseous element, heavier than the air, colorless, fuming in the air, decomposing water, and smelling like chlorine, of which it possesses some of the properties, such as bleaching organic matters and decomposing the bromides and iodides. However, most of its physical and chemical properties are likely unknown, for it is difficult to keep it for any length of time.

No combination of fluorine with oxygen is known. With hydrogen it forms an exceedingly corrosive compound, hydrofluoric acid, prepared by heating fluorspar (calcium-fluoride) with sulphuric acid in a platinum retort connected with a receiver of the same metal placed in a powerful frigorific mixture, into which the acid—which is gaseous at common temperatures—is liquefied. In that state hydrofluoric acid boils at 60 degrees, freezes at about 4 degrees Fahr., emits white fumes in the air, and when poured into water it unites with it with great energy, evolving considerable heat. It should be handled with care, for its action is very corrosive; a drop falling on the skin produces a painful ulceration long to heal. Its fumes are suffocating and dangerous to breathe. Ammonia at once combines with it, and can, therefore, be used to neutralize its fumes, but, as a remedy, it should not be depended upon, for the soluble fluorides are as poisonous as the acid itself. The best antidote is calcium chloride, followed by emetics.

Hydrofluoric acid attacks all the metals with the exception of lead, mercury, silver, gold, and platinum. It has no action on the metalloids, boron and silicium excepted. Its affinity for the latter is remarkable; it decomposes all the silicates. It is on this acid action that is based the engraving processes on glass, which is a compound of various silicates.

Many fluorides are soluble in water. They are obtained by the direct action of hydrofluoric acid on the metals, or by neutralizing their oxides with the acid. The fluorides of the alkali-metals (potassium, sodium, and ammonium) have an alkaline reaction, and slowly attack glass, which is thereby dispolished. Under the influence of heat this action is more rapid.

Sodium fluoride has been recommended by F. Scott Archer in the iron developer employed for rapid exposures in the wet collodion process. The formula is as follows:

Ferrous sulphate	7½ drachms.
Sodium fluoride	25 grains.
Glacial acetic acid	3 fl. drachms.
Formic acid	1 fl. drachm.
Alcohol	2 fl. drachms.
Water	1 pint.

On the suggestion of Blanquart-Evrard, it was also employed in the calotype, albumen, and collodion processes to introduce silver fluoride in the sensitive film as an accelerator. It is doubtful whether any advantage can be derived from it; moreover, silver fluoride is very soluble in water. No precipitate is formed when an alkaline fluoride is added to a silver nitrate solution.

To engrave on glass several processes are employed in manufactures. Generally, a thin coating of wax, dissolved in four parts of turpentine, is applied on the plate, and a design placed behind it is counter-drawn by removing the wax with a pointed tool. The plate is then placed over a lead tray containing a small quantity of finely powdered fluor-spar and sulphuric acid, to form a thin paste, when, by slightly heating, gaseous hydrofluoric acid is evolved, and in a few minutes etches the glass on the parts not protected by wax.

When an original design is drawn, some bitumen is dissolved with the wax, and the plate placed upon a sheet of paper in order to see the drawing white on a tinted ground. Another method consists in pressing into perfect contact with the plate a pattern waxed both sides, and to slightly soften the wax by heating the plate over an alcohol lamp in order to make it adhere everywhere. The whole is then submitted to the fumes of the acid, as above explained.

Good results are also obtained by applying on a finely ground glass and opal a pattern—lace, tulle, lace-paper, etc.—previously imbued with a greasy substance, and removing it after having carefully softened the waxy substance by heating the plate, so that it leaves its sharp, greasy impress thereon. In this case a dilute solution of hydrofluoric acid is poured on the plate, forming a tray by bordering it with wax; or, if more convenient, powdered fluor-spar and sulphuric acid are spread over the plate, letting the action proceed for a certain period. The engraving obtained by these latter methods is transparent on an opaque ground, for, what is remarkable, by etching with the fumes of the acid, the design is opaque; while it is transparent by dissolving the glass or other material with a solution of the same.

Similar processes are employed to engrave on glass ware—cups, goblets, bottles, etc.—but the object is then dipped in the dilute acid, poured in a gutta-percha vessel, taking care to protect by a stopping ground—shellac or bitumen varnish with wax—all the parts which should be reserved.

Although good etchings are made in manufactures by the processes just described, none, however, can be compared for delicacy of details and artistic effects to those which may be produced by photographic processes, using a negative or a transparency, according as the etchings should be made on ground, opal, or ordinary polished plate glasses, and, also, according to the method employed for etching. When the subject is taken from nature, or when an engraving in aqua-tint or lithography is copied, it is of course necessary to convert it into a photographic image in lines or dots. Several methods can be devised for that purpose. The following, which is also employed to obtain phototypographic tint blocks, is quite effective. It consists in placing between the disks and the plate prepared to receive the impression before etching, a print in straight dotted or crossed lines, 100 to 150 to the square inch—obtained from a copper plate or a boxwood block cut by machinery. These prints should be made on tracing paper or on collodion films.

To engrave it, it is best to select a glass ground depolished by hydrofluoric acid, which produces a grain much finer than that obtained by any other means. The reason of selecting such a glass is that its surface can be netted like a lithographic stone or a grained zinc plate, and retain moisture for a certain period, which is quite important, as will be seen further on.

The plates are prepared with a layer of bichromated albumen, upon which the impression is formed, or a carbon print may be developed on its ground surface.

First Process.—Beat to a thick froth the whites of say three eggs, 90 minims of concentrated aqueous ammonia, and 45 grains of potassium bichromate finely powdered. Let settle for a few hours, and decant the clear liquid, filtering it through flannel. This solution keeps well in the dark for three or four weeks.

For coating, provide a round wooden stem about 8 inches long, 3 or 4 inches in diameter, and cut at one end in the form of a cup, upon which should be adapted an India rubber ring, the whole forming a pneumatic holder. Upon this fix the plate firmly, wet its ground surface under a tap, let it drain, and flow twice over it, in opposite directions, the bichromated albumen, pouring off the excess in a vial. This done, tilt the plate to distribute the liquid accumulated at the edges, and, taking the holder between the hands, make it revolve slowly at first, then more rapidly, so as to leave on the plate a thin and even layer of albumen. Detach it now, place it on a leveled stand in the dark room, and let the film dry spontaneously. The plates should be prepared the day they are wanted for use, for in drying the bichromated albumen becomes insoluble in the dark in a short period.

The plate is now placed on a transparency with a clean plate on top, interposing between them the tracing paper printed into lines, as it has been explained, when it is exposed for about a minute in sunshine, 10 to 15 in the shade, and even for a longer period, according to the intensity of the light, for the parts acted on should be made insoluble through the whole thickness, otherwise the albumen would dissolve in the subsequent operation. After the insolation a printer's roller charged with ink is passed over the albumen film, so as to cover it with a very thin layer of soft diluted greasy ink.* The plate is then immersed in cold water, where in a certain period the albumen dissolves in the parts not acted on, carrying the ink with it. Sometimes, especially when the ink is a little thick, it is necessary to assist the development by rubbing the film with a soft rag under water until the lines stand perfectly clear.

After rinsing and drying, the plate may be etched by flowing diluted hydrofluoric acid over it, but it is advisable before so doing to pass again the roller, charged this time with hard ink, in order to well protect the reserve from the action of the acid. For that purpose the plate must be slightly wetted with a sponge imbued with gum water, which latter, being retained by the grain of the ground glass, prevents the ink from adhering to the clear glass. Indeed, from a plate so prepared, prints can be pulled out as easily as from lithographic stones or zinc plates.

Second Process.—Develop a carbon from print from a transparency on the ground surface of the plate, immerse the proof for a minute in a 2:100 solution of potassium bichromate, let dry, expose successively both sides of the plate to sunshine, wash out the bichromate, and when the film is dry, ink it and proceed as above explained.—*Anthony's Photographic Bulletin.*

* The ink, diluted with turpentine, can be applied with a pad of chamois leather when a roller is not at hand.

THE TELEPHONE, THE MICROPHONE, AND THE GRAMOPHONE.

By DAS TELEPHON.

HAD not the microphone been invented, there is no doubt that the electric telephone would have remained a simple electrical toy, and the transmission of speech to a distance—true, not to a very great distance—would be accomplished by the mechanical telephone. To the microphone is the world indebted for that great convenience—now a necessity in all business communities. In 1854 a perfect magneto receiver was invented by Charles Bourseul, but, alas! there was no instrument capable of transmitting electrical impulses sufficiently rapidly to actuate Bourseul's receiver so that speech could be reproduced. There is no doubt of the invention of the magneto receiver in 1854. It was described in a work published in that year, as is stated in the opinion of the Supreme Court of the United States, rendered March 19, 1888, in the famous Bell case, to which your readers are referred for the description, viz., "An electro-magnet in combination with a disk sufficiently flexible that it will lose none of the vibrations of the voice."

From 1854 to 1877 this little instrument of Bourseul remained unused and forgotten. Philip Reis even did not bring it out from its hidden place, and it remained for Prof. Bell to avail himself of the republication of its description in a book entitled "Wonders of Electricity," published in New York in 1872, at the very time Prof. Bell was occupied in his "multiple telegraph;" and in his patent of March 7, 1876, he substituted for Bourseul's iron disks a tympan of goldbeater's skin with an iron swinging armature, attached at one end to the center of the tympan. This device (invention ?) was made by Bell before February 14, 1876, the date of his application for a patent in the United States. Bell admits that when he filed that application he had never obtained articulate speech with any of his devices. No one, it seems, discovered that Bell's device was a bad imitation of Bourseul's perfect magneto telephone, although "Wonders of Electricity," containing Bourseul's description, was largely circulated. This ignorance by the public of Bourseul's invention permitted Prof. Bell to adopt the iron "disk" of Bourseul and claim it in his second patent, that of January 30, 1877, in the third claim, which is in the following words: "The combination with an electro-magnet of a plate of iron or steel. . . ." Is not that description of Bell's device identical with the description of Bourseul's instrument of 1854, as given by the Supreme Court of the United States?

From 1854 to 1877 Bourseul's perfect magneto receiver waited for the microphone, and the voice of man remained confined to the narrow limits imposed upon it in the garden of Eden.

1877 came; April 17 came, and on that day there was placed on the files of the United States patents a full description of a perfect microphone. An instrument made of materials capable of conducting electricity, having loose joints—the embodiment of the principle of the microphone, upon which all microphones must act. The inventor is Emile Berliner, at present a citizen of Washington.

The application filed on April 17, 1877, was in the nature of a caveat, which is filed in the secret archives of the Patent Office, and no one except the examiner in charge of the application has any right to see the application.

Not only does that application describe and claim the microphone, but it also names carbon as an excellent material in its construction. Prof. Edison filed an application for a carbon transmitter on July 20, 1877, but a patent was refused on the ground that Berliner had previously claimed the invention. The two claimants were put in "interference" by the Patent Office, and there the case remains undecided, for the simple reason that the American Bell Telephone Company owns both the inventions.

I am well aware that Prof. Hughes invented a carbon microphone in 1878, and there cannot be any doubt that he did invent it without having any knowledge of the invention in the United States. To *Emil Berliner* is due the credit of the invention of the microphone, as also of the carbon contacts in a microphone; but this is not his only really great invention. A few weeks ago I visited Mr. Berliner's laboratory, or rather his workshop, and I found him in his working-day clothes and apron busy on his latest invention, the "gramophone."

I sat down some 20 feet distant from his large trumpet. Mr. Berliner sat by the table behind the trumpet and slowly turned a small crank, and I heard all around me the following pieces of music:

"A little German march," by four brass instruments.

"Warrior Bold."

"A Venetian serenade."

"Cornet solo."

The execution was excellent and the tunes so loud that I heard well while walking about the room and into the passage.

Mr. Berliner then showed to me the process of preparing the plates, and recording thereon the air waves produced by the voice in speaking.

He took a flat, smooth disk of zinc, 12 inches in diameter and one-eighth inch thick. He poured upon it a liquid which looked like pale oil, which he termed "digested fat;" a very slight film remained on the disk, having become dry in half a minute; he repeated the same operation, and after about one minute he plunged the disk into cold water for half a minute; the disk, also the water at its surface, was coated with a fatty substance. He then placed the disk on the revolving table. I was then asked to speak against a small tympan about two inches in diameter, having a point of a common darning needle projecting from its center rest-

ing on the disk, which was revolved by Mr. Berliner. When I had finished speaking, Mr. Berliner placed the disk in a basin filled with acid, where it remained about twenty minutes.

He then took the disk out of the acid and washed off the remaining fatty substance, and with a magnifying glass I saw the wavy curved lines which had been eaten into the zinc disk, which was then put on the turning table, and the same device into which I spoke was set with the point of the needle in one of the concentric lines; the disk was turned, and I heard all that I said clearly and distinctly and loudly reproduced. I could not recognize my own voice, of course—no one can recognize his own voice. About two hours afterward I took a lady with me to hear the "gramophone;" the same programme of music was repeated, and when the disk with my recorded words was revolved on the table, the lady immediately looked at me with wondering astonishment and exclaimed, "Why, that is your voice."

Emile Berliner was born in Hanover, Germany, 1851, and came to the United States in 1870.

Baltimore, Nov. 23, 1888. —*Electrical Review.*

SIR DAVID SALOMONS' RESISTANCE GOVERNOR.

THIS instrument has been designed by Sir David Salomons for use, in connection with the well known repulsion regulator, and is made by the Woodhouse & Rawson Electric Manufacturing Company under his patents. It is intended for automatically introducing or withdrawing resistance from a circuit in case of an alteration of E.M.F., and in its mechanical construction is similar to that of the Porte Manville governor. The ratchet wheels are driven from any convenient rotating shaft, and, on an alteration of the E.M.F., an electromagnet draws one of the pawls into gearing with the ratchet wheel below it, causing the brush to move on to an adjacent contact, and so on till the proper E.M.F. has been reached by addition or subtraction of the necessary resistance. In case of the brush being carried right round to either extremity of the contact pieces, circuit is broken by its pressure against the contact pins.

Fig. 2 is another form of instrument designed for the same purpose. In this the ratchet wheels do not revolve from the shaft, but the brush is given a step by step movement on the action of the electromagnets, combined with the motion of the anchor escapement, which is mechanically driven from a shaft.—*Electrical Review.*

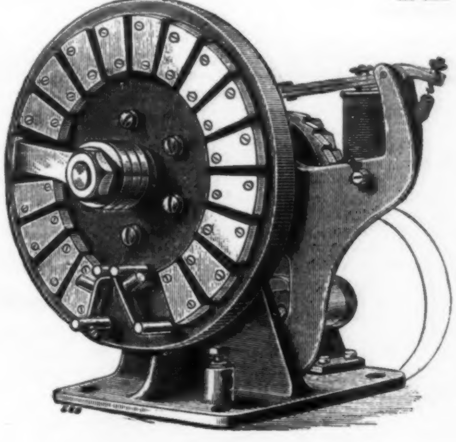


FIG. 1.

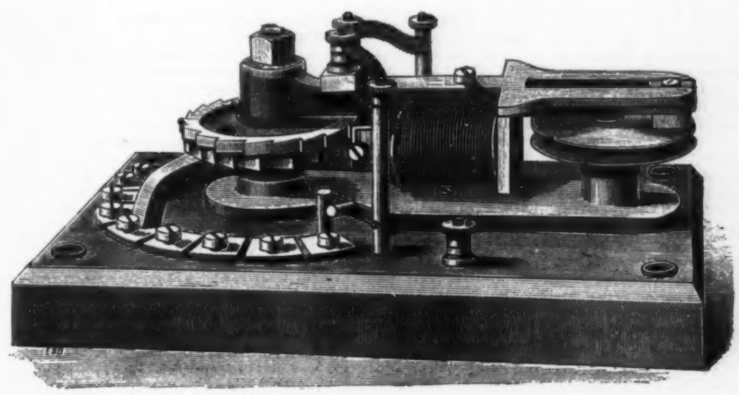


FIG. 2.

ELECTRIC WELDING.

THE process of electric welding invented by Professor Elihu Thomson has now been before the public for a considerable time, and has been the subject of many lectures and demonstrations. We have not, however, heard much of its practical application in the arts, all the accounts hitherto published dealing principally with the capacities of the system, and the production of sample objects, rather than with the results of actual work. A recent paper, however, read by Mr. C. J. H. Woodbury, of Boston, Mass., before the American Society of Mechanical Engineers, adds a valuable contribution to our knowledge of this subject in the results of a series of tests of electric welds made at the United States Arsenal, Watertown, Mass. The test pieces included wrought iron, octagonal steel, steel and wrought iron, copper, brass, brass and wrought iron, and brass and German silver, and varied in diameter from 1·74 in. to 0·25 in.

Commencing with the wrought iron, we find that the first sample had nearly 40 per cent. more sectional area in the weld than in the bar, and hence, as might be expected, it failed several inches away from the joint. The next was three per cent. smaller in the weld, and failed there at 49,500 lb. per square inch. The third test piece was parallel, and failed 3 in. away from the weld at 54,380 lb. per square inch. Next followed a series of tests on bars 1·02 in. by 0·4 in., having in the untouched state a strength varying from 53,500 lb. to 55,830 lb. per square inch of section. Five out of the seven samples were very distinctly larger in the weld than in the body, but nevertheless two of them gave way through the joint, where the section was increased by 25 per cent., the strain per square inch of the bar being 50,000 lb. in one case and 53,480 lb. in the other. The two parallel bars also gave way at the welds at an average of about 50,400 lb., while in the three cases in which the weld stood the trial its section was respectively 37 per cent., 47 per cent., and 36 per cent. greater than that of the bar. With bars of ½ in. round iron having an average strength of 58,000 lb., only one broke at the weld, where it was 4 per cent. less in cross section than the bar. The others all broke through the bar, the welds being from 23 per cent. to 70 per cent. larger in cross section.

The octagonal steel experimented upon had a breaking strain of about 127,000 lb. per square inch. Two welded specimens broke through the joint at 63,000 lb. and 76,000 lb. per square inch respectively, and two others broke at the end of the enlarged section of the weld at 90,000 lb. and 105,000 lb. respectively. When octagonal steel was welded to wrought iron, it was the latter which gave way in each instance, and not the joint.

In the copper tests the strength of three unwelded specimens varied between 32,390 lb. and 32,840 lb. per square inch. Out of four samples in which the joint was not more than 4 per cent. larger than the bar, three failed at the weld at strains from 29,450 lb. to 31,850 lb., and the other failed ¾ in. from the weld at 32,940 lb. The remaining bars had enlarged joints, and broke through the shanks. Among four welded brass bars two were the same diameter at the joint as in the bar; one failed at the weld at 40,820 lb. per square inch, and one gave way ¾ in. from the weld at 47,730 lb., the full strength of the metal. In the remaining bars the joint was enlarged 80 per cent., and stood the strain. When brass was welded to wrought iron, the joints failed at 17,450 lb. in one case and 33,550 lb. in another. A junction between steel and German silver bore 40,411 lb. per square inch before it broke.

In another series of tests distinctly better results were obtained. The steel welds, however, were poor, giving way at 70 per cent. of the breaking strain of the bar, unless they were much upset. The octagonal steel, however, showed two welds that were perfect, out of four samples. Among six samples of wrought iron, five were parallel; three failed at the joints at the full strength of the metal; and two broke 2 in. away from the joint at rather low strains.

The value of these tests is very much impaired by the increased size of the welds, which, in many instances, vitiates all comparison between the joint and the bar. Enough, however, is shown to demonstrate that an electric weld, like a hand-made one, may be either good or bad. The fact that perfect welds in wrought iron can be made shows that when the proper conditions are understood this system may be made to turn out most reliable work, for it is very nearly independent of the skill of the workman. We must remember, indeed, that in comparing many of these joints with the solid bar we are adopting an unreasonably high standard of comparison, and that we ought rather to take as our criterion brazed or soldered joints, which have hitherto been the sole methods of uniting such metals and alloys as copper and brass. In the case of the steel welds again, the heating to which they had been subjected must have greatly altered the local temper, and have rendered the metal much softer near the joint than elsewhere. The general results cannot fail to excite our enthusiasm and to raise the hope that a new method of dealing with metals is within our grasp, and that it will enable us to adopt forms of construction which have hitherto been scarcely possible.

The apparatus by which electric welding is carried out are exceedingly simple. Already they have been made of sufficient power to deal with 3 in. bars, and the makers talk of larger sizes yet. Two forms are shown in the engravings on the present page. Fig. 1 works on the indirect or transform system, and Fig. 2 on the direct system. In the former an alternate current dynamo, not shown in the engraving, supplies a current which is led round the primary coil of a secondary generator or transformer. The secondary coil is a single turn of a larger copper bar, and its ends are led to the clamps in which the rods to be welded are held.

The ends of the rods are placed in firm contact, and then the current is passed through them, its intensity being regulated by varying the primary current. As the resistance is greatest at the junction, this part rapidly gets hot, and the hotter it becomes, the greater grows the resistance. Rapidly the metal softens, and the clamps holding the bars are then fed forward to force the two surfaces together, and to cause them to unite. It is this pressure which causes the upsetting noticed in the test pieces. The union is complete in a time varying from a fraction of a second to two minutes, and then the current is stopped off and the article removed from the clamps. In the direct machine (Fig. 2) the dynamo is situated below the clamps, and has its armature wound with two coils; one is of fine wire to supply the current which excites the field magnets, while the other is a single copper bar which supplies the current for welding purposes. The ends of this bar are connected to rings from which the current is led by brushes to the clamps. In any case the electromotive force is very small, usually about half a volt, while the current, with large bars, amounts to thousands of volts. Power is only absorbed during the time that the metal is heated; at other times the generator runs idly.—*Engineering.*

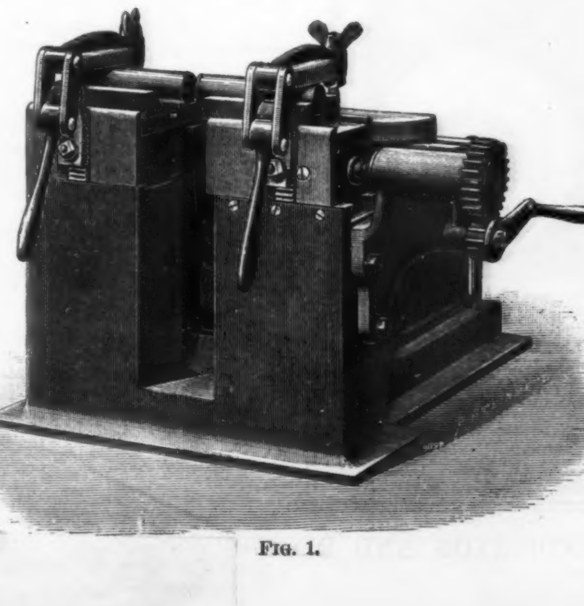


FIG. 1.

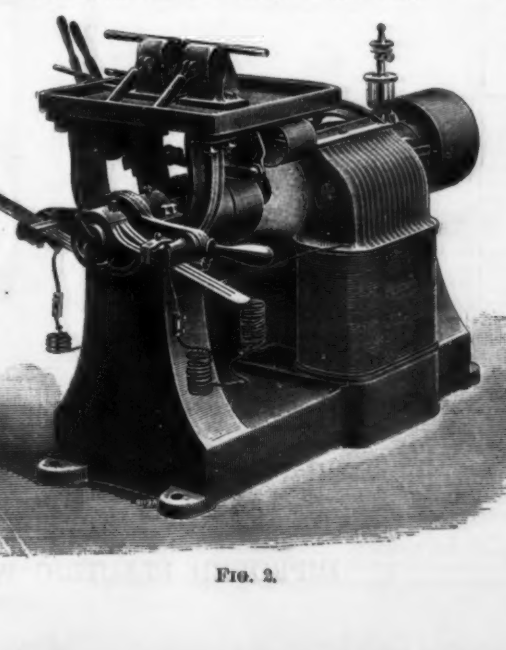


FIG. 2.

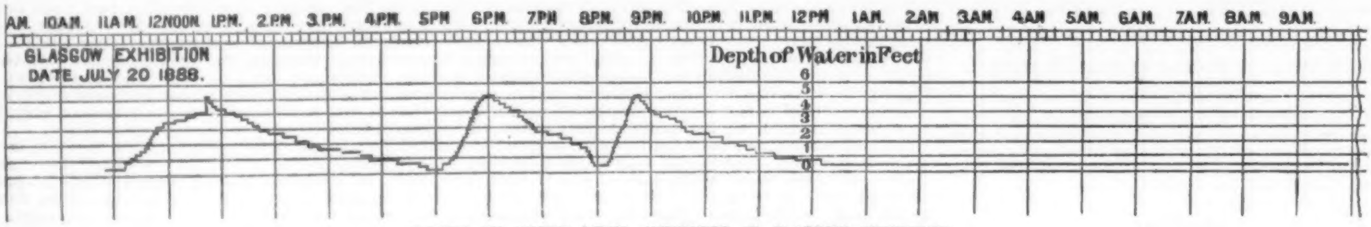
ELECTRIC WATER LEVEL INDICATOR AND RECORDER.

THE engravings illustrate Messrs. Barr & Macwhirter's electric water level indicator and recorder, which shows and keeps a record in the engineer's office of the variations in level of water in tank or reservoir at any distance. Every rise and fall of 3 in., or 1 in., or less, as may be desired, is telegraphed automatically and recorded on a drum by an aniline pen. The transmitting instrument, which is placed at the tank, or reservoir, is actuated by the rise and fall of the water by means of a float, to which is attached a pitched chain passing over pitch wheel, A. A counterbalance weight is attached to the other end of the chain to take up the slack; the toothed wheel, B, being on the same shaft as A, revolves with the rise and fall of float, and is geared into pinion, M, which, with its shaft, makes one complete revolution for every 3 in., or 1 in., as the case may be, rise or fall of float. The tumbling weights, T and T', are loose on the shaft, and tipped over by the pins fastened on S and S'. Pin R, which tips over T, is pivoted at one end, and is free to move to and fro in a slot in disk, S, the object being that T will be tipped over when in the same relative position when the shaft is revolving in either direction. The tumbling weights have a platinum edge, which, when they fall, comes in contact with the platinum contact pieces, C, C', C'', C'''. The pins in disks, S and S', are so placed that when tumbling weight, T, is falling over and making contact with C''', the smaller tumbling weight, T', is at the same instant in contact with C'; and when moving in the reverse direction, when T is in contact with C, T' is in contact with C''—thus completing the circuit at every increment of rise or fall of the water level, and telegraphing to the receiving instrument at the office. In order to insure that tumbling weight, T, may not fall too suddenly, and to give it ample time to make proper contact and complete the circuit, an eccentric, W, is carried on a prolongation of its boss, having a piston working in a small cylinder below filled with glycerine, thus forming a cataract.

The receiving instrument is worked by a relay battery. There are one or two battery cells at transmitter, simply for the purpose of sending a current over the line wire. This current brings into play for one or two seconds, by means of the relay, a more powerful battery placed near the receiving instrument. This relay battery moves the pointers on the dial, and works the recording pen.

When a current is transmitted from the reservoir, one of the coils, B or B', is for the time turned into a powerful magnet, which attracts the keeps fastened on lower ends of lever arms, H or H', respectively, thus throwing the top end of the arm forward, which then drops on the top of the ratchet wheel, A or A'. On the current being stopped, the lever arm is immediately released, and regains its original position by means of the recoil of springs, S or S', the ratchet pawl, J, being at the same time thrown up out of gear by the inclined plane on projections, N or N', coming into contact with the small roller. The distance of the keeps from the magnetic coils is regulated by screwed stoppers, as shown, and the tension of springs, S and S', is adjusted by screws in a similar manner. The same shaft that carries the ratchet wheels also carries the pointer, indicating on the dial the level of the water in the reservoir. The shaft also carries a pitched pinion, on which a pitched chain works, to which is attached a copper wire cord led over guide pulleys shown and carrying an aniline pen, which makes a record on the diagram paper on the drum of the water level in the reservoir; also a toothed wheel, A''', which with a spring acts as a detent to prevent the pointer moving either one way or another till the current actuates the lever arms. The whole receiving instrument, relay clock, and drum, are inclosed in a neat case of glass and mahogany.

All parts are open and accessible and easily adjusted. There are no fine adjustments requiring special skill to make. The contacts at the transmitting instrument are all sliding contacts, thus keeping themselves clean. The receiving instrument works well notwithstanding variations in the battery power, as it is the recoil of springs that gives the movement; so that so long as the battery is just powerful enough to attract the keeps, the instrument will do its work. The batteries do not require attention oftener than once a year. The apparatus described is made by the Glenfield Company, Kilmarnock.—*The Engineer.*



RECORD BY WATER LEVEL INDICATOR IN GLASGOW EXHIBITION.

AN INEXPENSIVE CELL FOR GALVANISM.*

By A. H. BUCKMASTER, M.D., Brooklyn.

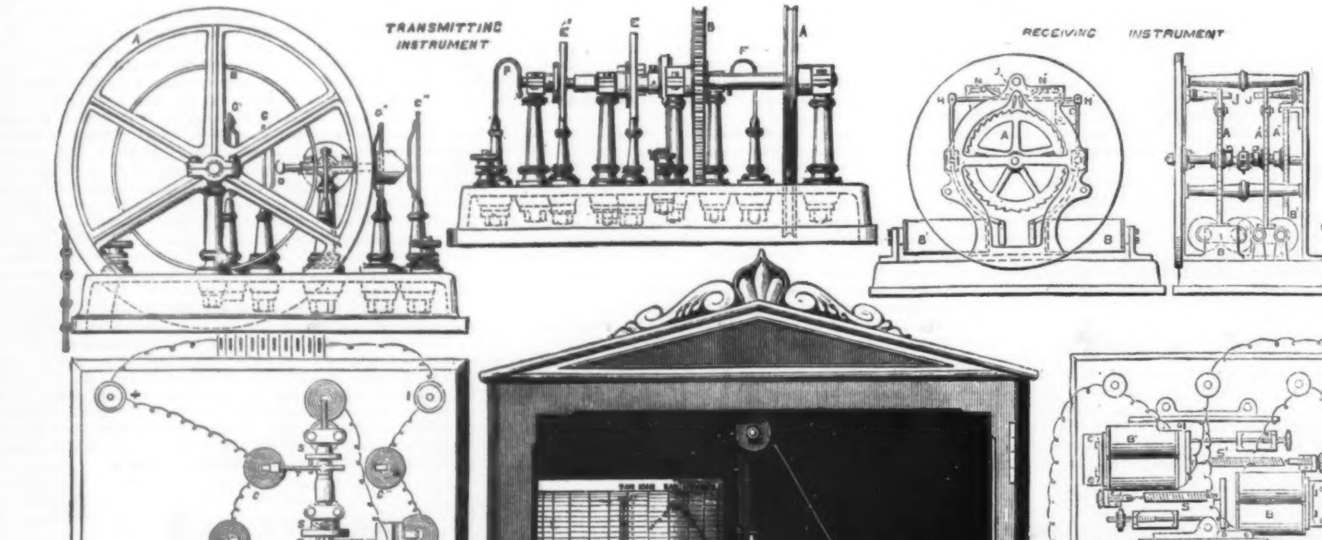
UP to within a quite recent period the use of electricity in a scientific manner was relegated to the neurologist. The gynæcologist has awakened to the possibilities of this potent agent, and, while there are some who believe they can use the current without a school book knowledge of electricity, many are giving their earnest attention to the subject. Many are deterred from testing its merits on account of the cost of the necessary paraphernalia, and of this the cost of the cell itself is no small item, and it is for the purpose of showing how a battery may be made at home at a comparatively slight cost that I trespass upon your time this evening. The glass jar is a common fruit jar, and can be bought in cases of eight dozen at a cost of about four cents apiece. It is only four inches in diameter, so that it may be placed on shelves between the jambs of the windows, etc., without projecting into the room in an unsightly manner. The jar holds a quart of fluid. The cover consists of six disks of pasteboard of two sizes tacked together. The three lower ones fit into the mouth of the jar, and the three upper and larger ones project slightly over the sides. There are two perforations in the cover to permit of the passage of the carbon and zinc. The aperture for the carbon is best made with a chisel, and that for the zinc can readily be made by a hollow punch. The zincs are six inches long, and have a transverse aperture near one end. A thread for a screw passes from the end, so that when a wire is passed through the aperture a few turns make it fast. The cost at wholesale of these zincs is about four cents. The carbons, $5\frac{3}{4} \times 1\frac{7}{8} \times \frac{1}{4}$, cost about six cents. Each should be bored near the top with a bit that is of uniform diameter, to make an aperture for fastening the wire. The exciting fluid is chloride of ammonium in solution, and it is sold in quantities for this purpose at about ten cents a pound. Two to three ounces is enough for each cell. If to this list we add the wire necessary for making the connections, we have all that is required for the construction of the battery.

A battery, to be useful to the gynæcologist, should conform to the following conditions:

1. The electro-motor force should be fairly constant.
2. It should not work on an open circuit.
3. It should be simple in its mechanism, so that the operator may readily provide for any irregularity in its working.

This cell conforms well to these requirements. The verdict of professional electricians to whom I have showed it has been that it would do the work required very well, but that perhaps more surface of carbon might make it more durable. If this should prove to be true, it would be a very simple matter to use two carbon plates with the zinc between them.—*New York Medical Journal.*

* Presented at a meeting of the section for Obstetrics and Diseases of Women of the New York Academy of Medicine, November 22, 1888.



IMPROVED ELECTRIC WATER LEVEL INDICATOR AND RECORDER.

ELECTRIC TRACTION AT THE STASSFURTH MINES.

THE mines of Stassfurth are of considerable importance. They furnish a large quantity of salts of potassa and rock salt. It is here that is collected *polyhalite* (triple sulphate of lime, magnesia, and potassa), *kieserite* (sulphate of magnesia), and *carnallite* (double chloride of potassium and magnesium). The mine has already a depth of 1,020 feet, and of 1,170 in certain places, and the ramifications of the subterranean galleries are very extensive. There is a gallery 900 yards in length. Under such circumstances, it may be conceived that it is difficult to carry the extracted products by wheelbarrow to the entrance of the mine. It would be very dangerous also to use a steam locomotive, by reason of the accidents that might supervene; so it was resolved to construct a small electric railway, and this has now been in operation since the beginning of 1884, to the entire satisfaction of the staff in charge of the works.

The installation was confided to the house of Siemens & Halske, of Berlin. It comprises an engine house located at the entrance of the mine, and in which there are two 16 horse power steam engines revolving at the rate of 50 revolutions per minute. These actuate an intermediate shafting which runs the dynamos. These latter are of the Siemens pattern, type D_2, and, at an angular velocity of 650 revolutions per minute, produce 350 volts and 42 amperes.

From the engine room start two cables which lead the current to two rails placed in the interior of the mine, and upon which rest sliding contacts connected with the receiving machine.

Fig. 1 represents the electric locomotive hauling

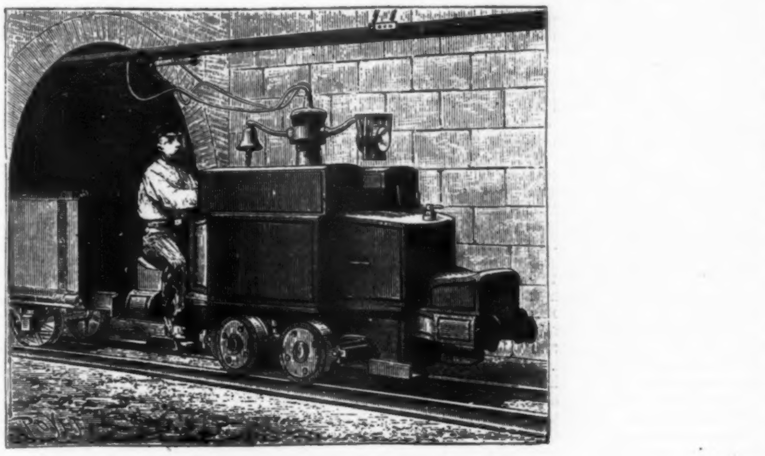


FIG. 1.—ELECTRIC LOCOMOTIVE OF THE STASSFURTH MINE.

cars. At the upper part may be seen the cables of which we have just spoken. The current enters the motor placed upon the locomotive and sets it in motion. The engineman has within reach an interrupter that permits him to break the circuit, and, consequently, to stop the train at will. This motor likewise is of the Siemens pattern, type D_1. The electric locomotive used is 3 feet in width and 5 in height. Its weight is 4,780 lb. During the year 1884, from Jan. 31 to Dec. 31, it hauled 176,196 cars without the necessity of any repairs being made. It has operated ever since under the same conditions.

Fig. 2 gives a plan of the engine house, which is situated at about 25 yards from the mouth of the

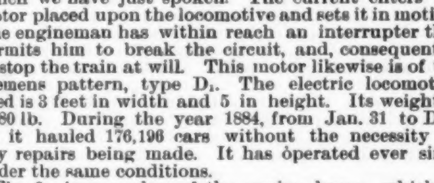


FIG. 2.—PLAN OF THE ENGINE HOUSE.

mine. The steam engines, the intermediate transmission, and the dynamos are shown.

Upon the same wires that serve to transport motive power to a short distance there are derived circuits for operating the ventilators.

Despite all the expense of the first establishment, the company has effected a saving of 50 per cent. over the former method of carriage by barrows.—*La Nature.*

REPORT ON THE EXAMINATION OF LIGHTNING CONDUCTORS.

By GUSTAV FRISCH, of the Electrotechnical Institute of the Imperial and Royal Technical High School at Vienna.

THE objects of investigation, according to the commission received, were the lightning conductors of the Theater and the Municipal Archives of the city of Oldenburg, in Hungary.

The conductor of the theater has three rods, terminating in points, and each of four meters in height. The height, number, and the arrangement of these rods is in accordance with the recommendations laid down by a committee of the Electrotechnical Association of Berlin, since the highest points of the building lie within circles whose radii are 1¼ times the heights of the rods.

The above-ground conductor passes down both fronts of the building into the earth, leading on the one side to a plate of 1 square meter sunk to the bottom of a neighboring well, and on the other side to a second plate of ½ square meter, which is laid in the moist earth beneath the sewer.

This conductor consists of a rope of copper wire made up of seven strands, each 2½ millimeters in thickness. It has consequently a metallic section of 34·3 square millimeters, and as there are two such conductors, there is a section of 68·6 square millimeters of copper available for the passage of electricity. The conductor is, therefore, as regards its dimensions, within the prescribed size of 65–70 square millimeters.

The conductor on the approach side of the theater passes into the ground by a rain channel, which has the disadvantage that an ocular examination of this part of the conductor is rendered impossible. Such an ocular examination of the continuity of the conductor, the integrity of the soldered joints, and the points of the receiving rods has been carried out annually by the officials of the city architect, and hitherto no defects have appeared.

The so-called "galvanometric" method was here first applied, and gave a satisfactory result. It was, however, regarded merely as a preliminary test, since it is only capable of detecting very gross defects.

A determination of the electric resistance of the above-ground conductor lead was not undertaken, because it cannot give the desired result, even if carried out with very accurate instruments. In the first place, the resistance of the conducting wires is much greater than the slight resistance of the rope of copper wire, and the latter, as Kohlrausch has shown, undergoes such trifling modifications, even in the case of considerable defects, that they cannot be detected by measuring the resistance. A thorough ocular examination is here decidedly preferable.

The conductor is in efficient connection with the metal roof, though certain sharp turns should have been avoided. If a conductor in obtuse curves would now no longer be possible, there is nothing left but to provide all curves with exit points.

In order to judge of a system of lightning conductors, it is particularly important to examine the ground conductor as to its resistance and the connection with any large masses of metal which may be present.

The resistance of the ground conductor was determined with the Kohlrausch telephone bridge, which, along with other necessary appliances, was courteously placed at my disposal by the director of the Electrotechnical Institute of the Imperial and Royal Technical School of Vienna, Prof. A. Von Waltenhofen. By means of this instrument the polarization of the earth plates is eliminated as far as possible, in consequence of the alternating currents employed.

As there is near the building a second well, at about 11 meters distance from the well above mentioned, containing one of the earth plates, the measurement was begun by applying one of the two conducting wires of the measuring bridge to the suction pipe of this second well, and the other to the aerial portion of the lightning conductor, when the resistance observed was determined. Repeated measurements gave a value of 25 ohms.

This resistance is composed of the earth resistance of the two plates—the value to be determined—increased by that of the auxiliary earth conductor in the second well. As the latter had a smaller surface, it could be admitted that the resistance sought for must be *smaller than half the value, 25 ohms, as found on observation.* In fact, on further measurements, in which the gas main in the street (not connected with the lightning conductor) was used as an auxiliary earth conductor, there was found a resistance of 11 ohms, which may be regarded as the diffusive earth resistance of the lightning conductor, as that of the gas main is very trifling.

If, in accordance with Neeson and Weinhold, we assume the maximum permissible earth resistance as 20 ohms, this result may be regarded as satisfactory, since by connecting the conductor with the gas mains, this resistance would be extremely diminished. Hence a more accurate measurement, according to the methods of Schwendler and Ayrton, Nippold, or Froelich, as originally intended, was not considered necessary.

The connection of gas and water mains to the conductor has latterly been made the subject of manifold investigations, and since such scientific bodies as the academies of Paris and Berlin, and the above mentioned sub-committee of the Berlin Electrotechnical Association, and in addition eminent specialists, such as Kohlrausch, Topler, Uppenborn, Von Waltenhofen, Weinhold, etc., have pronounced in favor of the necessity of such a connection, this question may be regarded as decided.

It must now be remarked that the lightning conductor of the theater was not in any way connected with the gas or water mains.

I therefore made the following sugestions:

The highest part of the system of gas pipes, *i. e.*, the pipe supplying the large gaselier, should be connected by a rope of copper wire of 65–70 square millimeters section to the conductor running along the ridge of the roof. In the same manner a connection is required at the part where the gas main enters the building. Such another rope of copper wire should be carried over the gas regulator and the meter, and a similar rope must be provisionally introduced whenever any portion of the gas system is removed for the purpose of repairs. This precaution applies not merely to gas piping within the building, but to any mains in the street near the theater.

The lightning conductor of the City Archives has two receiving rods, terminating in points, each 4 meters in height, placed at the front of the building. From these passes a rope of copper wire consisting of nine strands, each of 2 millimeters in diameter, having consequently a metal section of 28·3 square millimeters, and leading to a plate of 1 square meter surface.

The above-ground conductor was found to be in order. The resistance of the earth conductor measured by using the gas main as an auxiliary conductor (though it does not lead into the building, which is not supplied either with gas or water) amounts to 17 ohms.

This installation must be pronounced inadequate in several respects.

First, the receiving rods are both at the front of the roof, while the back and the ends are unprotected.

The conduction to the earth is far too feeble, and the earth resistance borders closely upon the limit considered as inadmissible.

I recommended the following alterations:

The erection of at least two further receiving rods, one at the side and one at the back of the roof. The conductor on the ridge is to be continued to these rods, and from thence a second conductor of at least 37 square millimeters section is to be carried down to a second earth plate of 1 square meter. This plate may be placed in the moist earth below the sewer in the court.

The reason why the authorities desired this investigation was that a private house, fitted with a conductor, had been recently struck by lightning, and a person in a bath had been injured.

I had no authority to undertake measurements in that house, or to examine the conductor. But I ascertained the following facts:

In the upper story of the house is a large iron cistern from which pipes pass down to the bath room in the lower stories. This reservoir was *not* connected with the conductor, and it was officially ascertained that the lightning struck over from the conductor to the reservoir. The pipe leading down from the reservoir does not lead to earth, but ends in a bath room on the ground floor, where it is closed by a cock. We can, therefore, understand that a person in the bath might be injured, since it had been omitted to connect the end of the water pipe with the waste pipe leading to the sewer. It is possible that the earth conductor had too high a resistance, but this case proves the necessity of connecting lightning conductors to the gas and water mains.—*Zeitschrift fur Elektrotechnik; Electrical Review.*

THE INFLUENCE OF THE DISCOVERY OF COCAINE UPON OPHTHALMIC SURGERY.

SINCE the discovery of the anæsthetic action of cocaine upon the conjunctiva so much has been written concerning its virtues, real and assumed, both as a local anæsthetic and as an internal remedy, that the subject would seem to be fairly well exhausted. It is of some interest, however, now that the experimental stage is past and cocaine has taken its place as one of the really valuable drugs that we possess, to see what effect it has had in modifying the treatment of affections of the eye.

At the last annual meeting of the Medical and Chirurgical Faculty of Maryland, Dr. Samuel Theobold presented a paper on this subject, of which the following is a brief *resume.* The action of the drug in causing anæmia of the conjunctiva and hardening of the cornea has had the effect of increasing the difficulty of subconjunctival tenotomy for the cure of strabismus. Not only is it less easy to pinch up a fold of the conjunctiva, but the muscle itself is in a state of tension. The difference is readily appreciated, the author says, when one has an opportunity to operate under chloroform anæsthesia after having performed a number of tenotomies under cocaine. One very noticeable change, and in many cases a matter of great convenience to the operator, is that the services of assistants can often be dispensed with, the patient himself, if old enough, being able to render all the aid that the surgeon requires.

There is a tendency at the present day for surgeons to return to the simpler operation of cataract extraction without iridectomy, and this is the direct result of the employment of cocaine. When the extraction is performed according to V. Graefe's method, the only part of the operation, as a rule, that is painful is the excision of the iris, and, as the danger of prolapse of the iris is reduced to a minimum with the doing away of the risk of vomiting after chloroform or ether, ophthalmic surgeons are beginning to leave the iridectomy unperformed. Although the corneal section is more difficult under cocaine, by reason of the drying of this tissue, the disadvantage is compensated for by the fact that the patient is conscious, and vision can therefore be tested.

Another modification in ophthalmic practice, which has come about as a result of the general employment of cocaine, is seen in the method of after-dressing. The former practice of applying compresses and bandages after operations, such as cataract extraction and iridectomy, is now being abandoned, and the eye is closed by simple strips of adhesive plaster, a method the advantages of which are obvious. This change is due to the fact that the necessity no longer exists for protecting the eye from the effects of vomiting and other accidents liable to occur when the patient is recovering from chloroform or ether anæsthesia.

Finally, in the treatment of granular lids the surgeon feels much less hesitation in using a remedy such as sulphate of copper, since the use of cocaine renders the

application of this substance painless. The patient has no dread of the applications, and the surgeon is not deterred from making them as often as he thinks necessary because of the distress which they may cause.—*Med. Record.*

[Continued from SUPPLEMENT, No. 681, page 10882.]

THE GASES OF THE BLOOD.*

By Prof. JOHN GRAY MCKENDRICK, M.D.

IV.

I HAVE now placed before you the generally accepted doctrines regarding the chemical and physical problems of respiration. But one has only to examine them closely to find that there are still many difficulties in the way of a satisfactory explanation of the function. For example, is the union of hæmoglobin with oxygen a chemical or a physical process? If oxyhæmoglobin is a chemical substance, how can the oxygen be so readily removed by means of the air pump? On the other hand, if it is a physical combination, why is the oxygen not absorbed according to the law of pressure? It is important to note that, as a matter of fact, hæmoglobin absorbs a quantity of oxygen nearly constant for ordinary temperatures, whatever may be the amount of oxygen present in the mixture of gases to which it is exposed.

This is true so long as the amount of oxygen does not fall below a certain minimum, and it clearly points to the union of the hæmoglobin with the oxygen being a chemical union. Suppose we diminish the amount of oxygen in the air breathed, the partial pressure of the gas is of course also diminished, but it is evident that we might diminish the total pressure instead of diminishing the amount of oxygen. To avoid difficulties in respiration, when one is obliged to breathe an air deficient in oxygen, we ought to increase the pressure at which the air is breathed; and, on the other hand, to avoid danger in breathing air under a low pressure, we ought theoretically to increase the richness of the air in oxygen. Thus, with a pressure of 760 mm. the air should contain, as it normally does, 21 per cent. of oxygen, while with a pressure of 340 mm. it should contain 46 per cent., and with a pressure of 250 mm. it should contain as much as 63 per cent. On this basis a pressure of 5 atmospheres should be associated with an atmosphere containing about 3 per cent. of oxygen. By increasing the pressure, we increase the quantity of oxygen by weight in a given volume.

The explanation is that in all of these cases the partial pressure of the oxygen is nearly the same, that is, not far from 157 mm. of mercury, and the general law is that for all kinds of breathing the pressure of the oxygen should be nearly that of the oxygen in ordinary atmospheric air. While the absorption of oxygen by the hæmoglobin has nothing directly to do with the pressure, it is striking that any atmosphere contains enough oxygen by weight for the hæmoglobin in the blood, when the partial pressure of the oxygen is near 157 mm. On each side of this median line life can be supported with considerable differences of pressure. Thus the pressure may be gradually reduced until the point of the dissociation of oxyhæmoglobin is reached—that is to say, down to about $\frac{1}{16}$ of an atmosphere. On the other hand, animals may breathe an atmosphere containing two or three times the normal amount of oxygen without appearing to be affected. This was first noticed by Regnault and Reiset, and the observation has been much extended by Paul Bert. The latter distinguished physiologist found that an increase even up to 8 or 10 atmospheres did not produce any apparent effect, but on reaching the enormous pressure of 20 atmospheres, death, with severe tetanic convulsions, was the result. He also showed that the additional increment of oxygen absorbed by the blood under the influence of each atmosphere of added pressure was very small. Thus, with a pressure of 1 atmosphere the amount of oxygen absorbed by the blood was about 20 per cent. by volume, a pressure of 2 atmospheres caused an increase of only 0·9 per cent., of 3 atmospheres 0·7 per cent., of 4 atmospheres 0·6 per cent., of 5 atmospheres 0·5 per cent., of 6 atmospheres 0·2 per cent., of 7 atmospheres 0·2 per cent., of 8 atmospheres 0·1 per cent., of 9 atmospheres 0·1 per cent., and of 10 atmospheres 0·1 per cent. Thus from 1 atmosphere to 10 atmospheres the increase was only to the extent of 3·4 per cent., so that the blood now contained 23·4 per cent. by volume instead of 20 per cent. These facts indicate that when all the hæmoglobin has been satisfied with oxygen it becomes indifferent, within limits, to any additional oxygen that may be forced into the blood under pressure, and thus the blood of animals breathing an atmosphere richer in oxygen than ordinary air is not more highly oxygenated than normal blood. The practical result also follows that it is of no use in the treatment of disease to cause patients to breathe an atmosphere richer in oxygen than ordinary air, because, at ordinary atmospheric pressure, no more oxygen can thus be caused to enter the blood, and if it be desirable to hyperoxygenate the blood, this can only be done by breathing oxygen, under a pressure of three or four atmospheres, in a chamber in which the body of the patient is subjected to the same pressure.

In this connection it is important to notice the enormous absorptive surface for oxygen presented by the red blood corpuscles of man. There are about 5,000,000 red corpuscles in each cubic millimeter. Each corpuscle has a superficial area of 0·000128 square millimeter. Taking the blood in the body of a man of average size at 4·5 liters, that is 4,500,000 cubic millimeters, the number of corpuscles is about 22,500,000,000,000, and this would give a superficial area of 2,880,000,000 square millimeters, or 2,880 square meters, or about 3,151 square yards—that is to say, the absorptive area of the blood corpuscles is equal to that of a square having each side about 56 yards. The hæmoglobin in a red blood corpuscle amounts to about $\frac{1}{10}$ of its weight. The blood of a man of average size may be taken at 4,536 grammes, or about 10 pounds. Such blood contains about 13·083 per cent. of hæmoglobin, and 4,536 grammes will contain about 593 grammes of hæmoglobin, or about $1\frac{1}{4}$ pound. As regards the iron, which is supposed to be an essential constituent of hæmoglobin, 100 grammes of blood contain 0·0546 gramme. It follows that the total amount, 4,536 grammes, contains about 2·48 grammes, or nearly 39 grains. Twenty-five minims of the tinctura ferri perchloridi contains about 1 grain of pure iron, so it will be seen that not many doses are required to introduce into the body an amount of iron as large as exists in the whole of the blood.

The absorption of oxygen, therefore, probably takes place as follows: the inspired air is separated in the alveoli of the lung by delicate epithelial cells and the endothelial wall of the pulmonary capillaries from the blood which circulates in the latter. The exchange of gas takes place through these thin porous membranes, so that the velocity of the transit must be practically instantaneous. As the oxygen is bound loosely to the hæmoglobin of the corpuscles, the laws of diffusion can have only a secondary influence on its passage, and only so far as it has to pass into the plasma so as to reach the blood corpuscles.

The plasma will absorb, at 35° C., about 2 volumes per cent., if we take the coefficient absorption of the plasma as equal to that of distilled water. Many of the blood corpuscles of the pulmonary blood have just returned from the tissues with their hæmoglobin in the reduced state, and the latter at once withdraws oxygen from the plasma. In an instant more oxygen passes out of the pulmonary air into the plasma, from which the oxygen is again quickly withdrawn by the hæmoglobin of the corpuscles, and so on. It is interesting to note that, if the oxygen did not exist in loose chemical combination, it would only be absorbed and its amount would depend on the barometrical pressure at the moment, and would follow each fluctuation of pressure through a range, say, of one-fourteenth of the total pressure. Such an arrangement could not fail in affecting health. If, on ascending a high mountain, say 15,000 to 20,000 feet above the level of the sea, the pressure sank to nearly one-half, the blood would then contain only half its normal quantity of oxygen, and disturbances in the functions of the body would be inevitable. High-flying birds, soaring in regions of the air where the pressure falls below half an atmosphere, would suffer from want of oxygen; but in deep mines and on high mountains men and animals live in a state of health, and the quick-breathing bird has a sufficient amount of oxygen for its marvelous expenditure of energy, because the amount of oxygen in the blood is independent of the factor which exercises an immediate influence on the gas contents of the fluid—namely, the partial pressure. Kempner has also proved that so soon as the amount of oxygen in the respiratory air sinks only a few per cent. below the normal, the consumption of oxygen by the tissues and the formation of carbonic acid also fall in consequence of the processes of oxidation in the body becoming less active.

It is a remarkable fact that, in certain circumstances, tissues and even organs may continue their functions with little or no oxygen. Thus, as quoted, Max Marckwald, in his work on the "Innervation of Respiration in the Rabbit" (translated by T. A. Haig, with introduction by Dr. McKendrick; Blackie & Son, 1888): "Kronecker and MacGuire found that the heart of the frog pulsates just as powerfully with blood deprived of its gases as with that containing oxygen, while the blood of asphyxia, or blood containing reduced hæmoglobin, soon stops its action."

Further, Kronecker has found that dogs bear the substitution of two-thirds to even three-fourths of their blood by 0·6 per cent. solution of common salt, and Von Ott withdrew 14-15 of the blood of a dog, and replaced the same with serum from the horse, free from corpuscles. For the first day or two after the transfusion the dog had only 1-55 part of the normal number of red blood corpuscles, so that it had only 1-55 part of its normal amount of oxygen. But this dog showed no symptoms except weakness and somnolency, nor did it suffer from distress of breathing, a remarkable fact when we consider that the blood of an asphyxiated dog still contains 3 per cent. of oxygen, and that it may show great distress of breathing when there is still one-sixth part of the normal amount of oxygen in its blood.

The conditions regulating the exchange of carbonic acid are quite different. We have seen that the carbonic acid is almost exclusively contained in the blood plasma, the smaller part being simply absorbed, and the greater part chemically bound, a portion existing in a fairly firm combination with a sodic carbonate of the plasma, and another portion in a loose, easily decomposable combination with the acid sodium carbonate, and a third portion with the sodium phosphate. Carbonic acid is contained in air only in traces, and its tension in the air is almost nothing. The air contained in the lungs is not wholly expelled by each respiration, but a part of the air of expiration, rich in carbonic acid, always remains in the lung. It is evident, then, that by the mixing of the air of inspiration with the air in the alveoli, the latter will become richer in oxygen and poorer in carbonic acid. The air in the alveoli, however, will always contain more carbonic acid than atmospheric air. Pfluger and Wolffberg have found the amount of carbonic acid in alveolar air to be about 3·5 volumes per cent., therefore its tension will be $\frac{3·5 \times 760}{100} = 27$ mm. of mercury. The tension of the carbonic acid in the blood of the right ventricle (which may be taken as representing venous pulmonary blood) amounts, according to Strassburg, to 5·4 per cent. = 41 mm. of mercury, and is 14 mm. higher than that in the alveoli. Carbonic acid will, therefore, pass by diffusion from the blood into the alveolar air until the tension of the carbonic acid has become the same in the blood and in alveolar air. Before the state of equilibrium is reached, expiration begins, and removes a part of the air out of the alveoli, so that the tension of the carbonic acid again becomes less than that in the blood. During the expiration and the following pause, the elimination of carbonic acid continues. This physical arrangement has the advantage for diffusion, that by expiration the whole air is not driven out of the lungs, for, if expiration had emptied the lungs of air, the diffusion would have ceased altogether during expiration and the follwing pause, and diffusion have been possible only during inspiration. There would thus have been an incomplete separation of the carbonic acid from the pulmonary blood. But as air remains in the lungs, the stream of diffusion between pulmonary blood and pulmonary air goes on steadily, and fluctuations occur only in regard to its velocity (Munk).

Any account of the gaseous constituents of the blood would be incomplete without a reference to the ingenious theory recently advanced by Prof. Ernst Fleischl von Marxow, of Vienna, and explained and illustrated in his work "Die Bedeutung des Herzschlages fur die Athmung; Eine Neue Theorie des Respiration," a work distinguished alike by the power of applying a profound knowledge of physics to physiological problems and by a keen and subtile dialectic. The author starts with the antagonistic statements that of all animal substances, hæmoglobin is the one which possesses the greatest affinity for oxygen, or that substances exist in the animal body which, at least occasionally, have a greater chemical affinity for oxygen than hæmoglobin possesses. If the tissues have a greater affinity for oxygen than hæmoglobin has, how is it that in the blood of animals that have died of asphyxia there is still a considerable quantity, in some cases as much as 5 volumes per 100 volumes, of oxygen? It is well known that the blood of such animals always shows the spectrum of oxyhæmoglobin. The tissues, then, do not use up all the oxygen of the oxyhæmoglobin, and they cannot, therefore, have a stronger affinity for the oxygen than hæmoglobin has. On the other hand, as the tissues undoubtedly seize hold of the oxygen, and rob the hæmoglobin of it, it would appear as if they really had a stronger affinity for the oxygen. There is thus a contradiction according to Fleischl von Marxow, and it shows that our theories as to the ultimate chemical changes of respiration are not valid.

It might be objected at this point that the death of an animal from asphyxia, while oxygen still remains in its blood, is no proof that the tissues have lost their power of removing oxygen from oxyhæmoglobin. It only indicates that certain tissues, probably those of the nervous centers, require more oxygen than is supplied to them; and, therefore, this part of the bodily mechanism is arrested, with the result of somatic death. Other tissues still live, and use up oxygen so long as their vitality lasts. At the same time, I am willing to admit that it is a striking circumstance that the nervous tissues stop working before they have exhausted every atom of oxygen in the blood.

But if tissues have, as all admit, an affinity for oxygen, and if at the same time we grant, for the sake of argument, that this affinity is not strong enough to dissociate the oxygen from the oxyhæmoglobin, can we perceive any physical action which would, in the first place, perform the work of dissociation, and then present the oxygen to the tissues in a form in which they would readily take it up? Ernst Fleischl von Marxow holds that he has discovered such an action or agency in the stroke of the heart. He founds his theory on some remarkable experiments, which may be readily repeated with an ordinary tight-fitting hypodermic syringe. (1) Immerse the syringe wholly in water, so as to exclude air. Place one finger over the nozzle, draw up the piston for about half the length of the syringe, and then suddenly remove the finger from the nozzle. The water will rush in, and gas will be given off in considerable amount, the water being quite frothy for a short time. This is what one would expect. (2) Then carefully empty the syringe of air and gently draw it half full of water; then place the finger on the nozzle and draw the piston up a little, so as to leave a vacuum above the water. In these circumstances a few large bubbles of gas will come off, but the water will not froth. (3) Empty the syringe thoroughly, fill it half full of water, raise it obliquely so that the knob at the end of the handle of the piston is above the water, strike the knob sharply with a piece of wood, using the latter as a mallet; then draw the piston up a little, so as to leave a vacuum above the fluid. You will now observe that so large an amount of gas is given off as to cause the fluid to froth. In this experiment, the percussion stroke has evidently altered the mode in which the gas escapes when a vacuum has been formed above it.

These experiments may also be done by using a long barometer tube, with a stop cock at one end, and an India rubber tube communicating with a movable mercury cistern (a bulb) at the other. By lowering and depressing the bulb, a Torricellian vacuum may be formed, and water may be admitted, as with the syringe. Of the effects of percussion, in these circumstances, there can be no doubt, and the experiments are extremely interesting from the physical point of view. Fleschl von Marxow holds that when gases are dissolved in fluids, the condition is analogous to the solution of crystalloids. If a fluid containing gas is shaken, more especially by a sudden, sharp stroke, the close connection between the molecules of the fluid and of the gas is rent asunder, and the gas molecules lie outside, and between the molecules of fluid. A shock, therefore, converts a real solution into a solution in which the fluid and gaseous molecules are in juxtaposition; and, if a vacuum is formed soon after the stroke, small bubbles of gas make their appearance more readily than if a stroke had not been given.

He then applies this theory to the phenomena of the circulation and of respiration. Starting with the query why the stroke of the heart should be so sudden and violent, when a much slower and more prolonged rhythmic movement would have been sufficient to keep up the tension in the arterial system on which the movement of the fluid depends, he boldly advances the opinion that it serves for the separation of the gases. The blood is kept in motion by a series of quick, sudden strokes, because, for the taking up of the oxygen by the tissues, and the elimination of carbonic acid by the lungs, it is not sufficient that the blood runs steadily through the systemic and pulmonary circulations; and, therefore, a short, hard stroke is given to it immediately before it enters the lungs and immediately after it has left the lungs. These strokes liberate the gases from a state of solution, and they become mixed with the fluid in a state of fine dispersion. This condition of fine dispersion is favorable for the elimination of the carbonic acid by the lungs, and for the using up of oxygen by the tissues.

Fleischl von Marxow then proceeds to state that loose chemical combinations may also be dissolved by shocks, the gas passing into a condition of fine molecular dispersion, and that a quick repetition of the shocks prevents a recombination. As examples of such loose combinations, he cites oxyhæmoglobin and the compounds of carbonic acid with the salts of the plasma. It is here, in my opinion, that the theory fails, from want of experimental evidence. There is no proof that shocks, such as those of the contraction of the

* Address to the British Medical Association at its annual meeting at Glasgow. Delivered on August 10 in the Natural Philosophy class-room, University of Glasgow, by John Gray McKendrick, M.D., LL.D., F.R.SS.L. and E., F.R.C.P.E., Professor of the Institutes of Medicine in the University of Glasgow.—*Nature.*

right and left ventricles, can liberate gases from loose chemical combinations such as those with which we have to deal, and it is somewhat strained to point to the explosion of certain compounds excited by strong mechanical shocks or by vibratory impulses.

Some of the applications of the theory are very striking. For example, Fleischl von Marxow suggests that asphyxia occurs before the oxygen has disappeared from the blood, because it is held by the hæmoglobin so firmly that the tissues cannot obtain it. Thus suppose no oxygen is admitted by respiration. It is well known that all the blood in the body passes through the heart and lungs in the time of one complete circulation—that is, in about twenty seconds; and we have it on the authority of Pfluger that in this time one-third of the oxygen is used up by the tissues. According to the percussion theory, the stroke of the left ventricle arterializes the blood—that is, liberates the oxygen from the hæmoglobin—and this arterialized blood is carried to the tissues. The hæmoglobin does not get sufficient time to recombine with the oxygen, because of the successive strokes of the heart and the vibrating thrill kept up in the arterial ramifications.

The free oxygen is used up by the tissues in the capillary circulation, to the extent of one third. After leaving the capillaries, the two thirds of oxygen again recombine with the hæmoglobin, and in this condition return to the heart, along with one third of hæmoglobin that has lost its oxygen. In ordinary circumstances this one-third would again obtain oxygen from the alveoli of the lungs; but if all the oxygen there has been used up, of course it cannot obtain any oxygen. The blood flows from the lungs to the left ventricle, when it is again arterialized, and again sent out through the arteries: but as there is now a large amount of free hæmoglobin present in the capillary circulation, it will seize hold of a part of the oxygen, and the tissues will obtain less than the usual supply. With each successive circulation, the amount of oxygen available for the tissues will become less and less, until the tissues receive none, because all the oxygen set free by each beat of the left ventricle is seized hold of in the capillary circulation by the reduced hæmoglobin. The tissues die from want of oxygen, because there is too much reduced hæmoglobin present, a substance having a greater affinity for oxygen than the tissues possess, a result that would perhaps occur, as in drowning, in the time of six or eight complete circulations—that is in three or four minutes.

Time will not allow me to refer further to this ingenious theory, which still requires the proof that such shocks as those of the heart can liberate gases from the compounds that exist in the blood. In my opinion, Fleischl von Marxow exaggerates the importance of the shock, while he underestimates the evidence of the spectroscope, which always shows the spectrum of oxyhæmoglobin even in arterial blood drawn from the neighborhood of the heart, and kept from contact with the air. Nor can I accept his statement that the force of the stroke of the heart is practically the same in all classes of warm-blooded animals, and one can hardly imagine the feeble stroke of the left ventricle of a mouse would be sufficient to liberate the oxygen from the oxyhæmoglobin of its blood. Further, it may be urged that the conditions of the experiments with the syringe are very unlike those of the circulation, more especially in the fact that the walls of the syringe are rigid, while those of the heart and vessels are yielding and elastic. Again, when an organ is supplied with a solution of oxyhæmoglobin from a pressure bottle, by a process of transfusion, the tissues will reduce the oxyhæmoglobin, and take up the oxygen without any kind of percussion action being brought into play.

Physiologists, however, cannot but treat with the greatest respect the experiments and reasoning of a physicist so able as Fleischl von Marxow is known to be, and the theory will be thoroughly tested in every detail. I may be allowed to contribute an expression of deep interest in this brilliant speculation, and to say that I entirely agree with its author in accepting the suggestions of teleology in the investigations of such problems. While the rigid investigation of facts is no doubt one of the great methods of science, we must not forget that by asking questions as to the use or value of a particular physiological arrangement, we may obtain light as to the road along which investigations are to be pursued. This is the guiding star of Fleischl von Marxow's speculation, and it has led him and other physiologists to scrutinize anew the theories of respiration now in vogue.

In this address we have had abundant evidence of the fact that physiology, in the solution of some of her problems, depends entirely upon the methods of chemistry and physics. The air pump, the special advantages of the mercurial air pump, the methods devised for collecting and analyzing the gases of the blood, the spectroscope, have all contributed important facts to our knowledge of respiration. The narrative placed before you also illustrates in a striking manner the relation of modern physiology to the physiology of our forefathers. The latter were engaged in observing and explaining the more obvious phenomena, while the modern physiologists are pushing their researches further, and are endeavoring to study the hidden phenomena, which, like a second order, lie behind these. I need scarcely add that even the results of modern research are not to be regarded as final. Although we see a little further and more clearly than those who went before, there is still uncertainty as to fact and obscurity as to explanation in most departments of physiological science, and not least as regards the function of respiration. Enough has been said to show that in the study of respiratory mechanisms we meet with numerous examples of the same wonderful adaptation of organic structure to physical conditions as may be traced in the mechanism of the eye and of the ear. The structure of a lung or of a gill is just as much adapted for the play of the physical laws regulating gases as the retina is tuned to the vibrations of the ether, or as the organ of Corti responds sympathetically to the waves of musical tone.

List of Experiments in Illustration of the Lecture.

1. Appearance of blood after having been shaken with carbonic acid.
2. Appearance of blood after having been shaken with hydrogen.
3. Appearance of blood after having been shaken with nitrogen.
4. Appearance of blood after having been shaken with oxygen.
5. *Fac-simile* model of Leeuwenhoek's syringe, by which gases were first demonstrated in the blood.
6. Absorption of ammonia by water.
7. Gases escaping from water in Torricellian vacuum.
8. Gases escaping from blood in Torricellian vacuum.
9. Spectrum of oxyhæmoglobin shown by electric light.
10. Spectrum of reduced hæmoglobin; the reduction effected by ammonium sulphide.
11. Spectrum of oxyhæmoglobin changing into that of reduced hæmoglobin by heating blood *in vacuo*.
12. Demonstration of a new gas-pump for the physiological lecture table (Figs. 1, 2, and 3).
13. Demonstration of the use of Pfluger's gas-pump.
14. Collection of blood gases and demonstration of the existence of carbonic acid and of oxygen.
15. Carbonic acid collected from a solution of carbonate of soda *in vacuo*.
16. Method, by use of thermo-electric piles with galvanometer, of observing thermal changes attending formation of oxyhæmoglobin.
17. Demonstration of Fleischl von Marxow's experiments, not with a syringe, but with the fluid in a Torricellian vacuum so arranged as to receive a shock.

Dr. McKendrick asks us to direct the attention of our readers to a statement in his address which he wishes to correct. He stated: "If the union of oxygen with the coloring matter is an example of oxidation, it must be attended with the evolution of heat, but, so far as I know, this has not been measured." He then referred to a method by which Mr. J. T. Bottomley and he had been able to observe the heat produced. Dr. McKendrick was not then aware of an important research on this subject conducted in 1871 by his friend Dr. Arthur Gamgee, and contained in a report to the British Association for the Advancement of Science in 1871. Dr. Gamgee, both by the use of thermometers and by thermo-electric arrangements, demonstrated the important fact that an evolution of heat accompanies the union of oxygen with hæmoglobin, and in the report referred to there is ample evidence that the research was conducted with great skill and with an appreciation of the difficulties to be surmounted. He arrived at the conclusion that "the mean rise of temperature during the absorption of oxygen amounted to 0·0976° C. The maximum heating found was 0·111° C., and the minimum 0·083° C."—*Nature.*

A FEW HINTS ABOUT DRAINAGE.

By F. W. CHANDLER.

IN the selection of a site for the country house, however great the attractions may be, avoid any not well drained naturally. Much can be done by artificial drainage, but any ordinary filling only raises the finished surface a few feet more or less above the wet, which is difficult to drain away. This applies particularly to level lands, as on a slope drains may be laid that will lead the water to the surface at a lower grade than the bottom of the house cellar.

On the other hand, the soil may be perfectly dry, but hard and clayey, land that in the spring time makes the plastered walls of the cellar damp, and wet spots to show, perhaps, on the cellar concrete; for after heavy rains, because the soil will not leach, the water will follow down along the house and easily find an entrance through the ordinary cellar wall. This is land perfectly healthful to live on, if it can be drained to take care of the few wet months, for during the long summer everything is perfectly dry. If there is a public sewer, both the sewage and this water can be taken care of satisfactorily. If there is no public sewer, then reliance must be placed on the cesspool. In considering either case, the draining of the cellar wall is the first part of the system to be arranged for in the order of building. The bottom of the wall begins commonly from twelve to eighteen inches below the finished cellar floor. The trench from the outside of the cellar wall to the bank should be at least twelve inches wide at the bottom and two feet at the top; this allows plenty of room to examine the building of the wall, to see that it is carefully pointed to shed water, or to see that the outside of the wall is thoroughly plastered with clear cement—a valuable precaution to take with a wet soil. At the bottom of this trench the drain pipe is laid, and above this the filling may begin with small stones, gravel free from clay, or sand, allowing eighteen inches at the top for loam.

In the laying of this drain pipe care must be taken to have a regular fall to the outlet; the grade may be as one in four hundred and be effective. The highest point of this drain pipe should be at the bottom of the footing stone of cellar wall, and the lowest point nearest to the sewer or cesspool, as the case may be. The drain pipe used for this work should not be the agricultural tile drain so commonly used, but should be of second quality glazed pipe four inches in diameter, as advised by Mr. Ernest W. Bowditch. This second quality is perfectly strong, but the glazing is imperfect, or it may be twisted, or the hub cracked or broken, all faults of no consequence in this work. In regard to expense, this second quality costs less than the ordinary drain tile. The great advantage of this pipe is the security of a large, clean aperture effected by the hub. The tile drains are only two or three inches in diameter, and are usually laid from one-quarter to one-half inch apart. This aperture is covered with tarred paper or cloth to prevent the earth working in, and then the trench is filled up; but with the greatest care taken, these tiles often get entirely choked up, and the porosity of the tile amounts to nothing.

Mr. Bowditch has been called upon a number of times as an expert to find a reason why the cellar walls and floors should be wet, when the system of drain tiles had been laid in the most thorough manner, and has invaribly found the choking up of the tiles with earth to be the cause, and has replaced the same with the four-inch glazed pipe with entire success. This pipe should be laid with the hubs pointing downward, as a better protection against earth entering the joints, which are, of course, uncemented. When the trench is carefully graded, it is better in laying this pipe to cut out still more of the earth for each hub, to insure an even bed for the pipe; and when the entire circuit of the walls is made, and the two ends joined to make one outlet, this must be entered into a trap, and this connection made as thoroughly as possible with clear cement.

Whether this drainage pipe enters into the trap, or is led out to the surface at a lower level, it is important that a copper wire netting should be so placed as to prevent rats or other vermin entering, as they might if the pipes became dry; this netting should be put into the end of the second length, so that the last length can be crowded against it, and so insure its remaining. The trap must hold a large amount of water to guard against too rapid evaporation; it should be at least two feet and a half in diameter, with fourteen to sixteen inches depth of water. It may be built of brick laid in cement, or it may be of one of the patterns now found in the market. The outlet from this to the drain must begin with a bend which should lead down to almost touch the bottom, and where passing through the wall of trap must be cemented in the most thorough manner, and the rest of this outlet pipe must be laid carefully in cement, the hubs pointing upward to its connection with the sewer—this outlet pipe being of the best glazed pipe.

It must be borne in mind that during the summer months the soil will probably be entirely dry, the water in the trap will naturally evaporate, the seal be thus lost, and sewer gas then have free entrance through trap and inlet, and so about walls of house. To avoid this danger, it is best to lead one of the rain-water conductors from roof into this trap, and as a further precaution, as in case of a drought, build a chimney from trap to top of ground with an iron cover, so that it can be filled by a hose or other artificial way. In this case the rain-water conductors should each have an S-trap, or a larger one if possible, at its foot, to lead into a system of their own similar to that draining the walls, the final outlet to enter wall waste-pipe beyond the trap. It must be understood that the work thus described is from necessity, not choice, as in every case where it is possible to do so this subsoil drainage should be led to lighter soil, where it can leach away and be a system of its own, not even connecting with a subsoil sewage system, in which case there need be no trap; but do not omit the copper wire netting before spoken of. It may be found as the work progresses that at times water comes up through the cellar floor, and this must also be taken care of. Such a floor must be covered with at least six inches of broken stone throughout, besides the finish of concrete; but in addition a graded trench should be dug, say six inches deeper at the lowest part, and twelve inches wide; this trench should be the whole length of the inside walls, running parallel with them, and say twelve inches away. At the lowest part of this trench put in a trap, and from this trap lead a four-inch iron pipe with bend, turned down to almost touch bottom, and lead the other end through the outside wall into trap above water line, if waste must finally enter sewer, or into the subsoil drain of a water conductor if the overflow is allowed to leach into the soil. This cellar trap is made by the Akron and Portland companies, and seems to be all that is wanted. It is of glazed earthenware, with an iron cover, about sixteen inches in diameter and two feet long. It is a regular cylinder, and the upper half is perforated with small holes, and when the trap is sunk so that the cover is flush with finished floor, these perforations are opposite the broken stone stratum through which filters the water. It very rarely happens when the walls are properly drained that there is any appearance of wet on the cellar floor, but this is a very valuable expedient for an old building where the foundation walls are so poorly built that the earth cannot be removed from the outside of them to put the drains there, without endangering its stability, or for any cause where it is not desirable or feasible to put in the outside drain. The inside drain will do the work perfectly well, but of course it would be better if this dampness were outside the cellar walls.

One could hardly wish to build where all these precautions are necessary, and it might be said that such conditions are rare; but there might happen even a more complicated case where there is no sewer, and tight cesspools must be used, either because the earth will not leach, or there is not area enough to allow of sufficient subsoil drainage. In this last case there must be a cesspool for the sewage, and another for the cellar drainage; pumps should be fixed over them, and they must be emptied regularly.

Thus far there has only been considered the drainage necessary for a dry cellar, and the mode of entering the soil pipe into the sewer is too well known to need further explanation; but in the case where the sewage can be disposed of by subsoil drainage, the method as carried out by Mr. Bowditch seems by far the best, and this method was also devised to take the place of the intermittent flushing tank with its system of main and lateral tile-drains, which may under favorable circumstances work well enough, but cannot be relied upon. The same difficulty obtains in this case as about the cellar walls; the small pipes are too easily choked; more or less of the system thus becomes inoperative, the drainage becomes too concentrated, and the first sign of failure is the appearance of wet on the surface of ground—it "fountains up." Then, again, the complication of flush tank should be avoided in every case, until a better reason for using them is found than now exists; they are liable to, and do, get out of order. The system, as carried out by Mr. Bowditch, is to have a tight cesspool at least fifty feet from the house, into which is led the soil-pipe and overflow from grease-trap. This cesspool should be three feet in diameter and five feet high, and the inlet should enter at the top, and the outlet to run out say three feet from the bottom, so that all solid matter shall remain in the cesspool, which must be cleaned out occasionally. Of course the connection of house with cesspool must be of the best pipe and with tight joints, but the outlet is to be built of the second quality of glazed pipe, as before spoken of, to be five inches in diameter, laid with the hub pointing downward. If the soil will allow it, Mr. Bowditch digs trenches for the main and lateral drains from three to four feet deep, say ten inches wide at bottom and eighteen inches at top. This trench is then filled in with broken or small stones, so that when the pipe is laid on them, there shall be eighteen inches of loam over the top of pipe. The lateral drains are put in twenty to twenty-five feet apart, and their

length is limited by the size of the land; for example, a lateral of one hundred feet might be enough; but if it were found insufficient, the main should be continued twenty feet and another lateral built on; and gates are put in, so that the sewage may be directed into any lateral desired, to give others a rest. If the topography of the land is favorable, it is a good plan to lead a waste-pipe from bottom of cesspool out to the lower slope, where a compost heap is collected, and allow the entire cesspool to run out at regular intervals. The pipe in the trenches should be placed as near the surface of ground as possible, but not so near as to endanger its working in winter. Eighteen inches of soil is not too deep for the air to penetrate, and its oxygen is doubtless more effective in the purification of sewage than the action of plant life. During the winter, the one is of course inoperative, and the other must be very much hindered by the frozen ground, so that during this time sewage must be got rid of principally by leaching.—*Technology Quarterly.*

[Continued from SUPPLEMENT, No. 681, page 10880.]

YEAST: ITS MORPHOLOGY AND CULTURE.*

By A. GORDON SALAMON, A.R.S.M., F.I.C., F.C.S.

LECTURE II.—CONTINUED.

IT is this reflection which leads us to doubt the value of much of the work that has been done in connection with the chemistry of yeast, since in no one instance have the cultures been pure. The preparation of pure cultures was then Hansen's first care, and he has elaborated a system of production which will be fully laid before you. It must not, however, be imagined that the matter had wholly escaped the attention of Pasteur. He refers to it in his *Etudes sur la Biere*, and suggests a method based upon the conception that, if yeast in the form of fine dust be dissipated throughout a sterile atmosphere, and a series of flasks containing sterilized wort be quickly opened and closed in the room in which the yeast has been sprinkled, in some of the bottles, at any rate, a single cell should descend and give rise to a pure culture. This method was uncertain, and did not lead to any significant discovery. As soon as Hansen had obtained his pure cultures (illustrations of which are appended), he promptly made an observation of the utmost importance, and one which showed that the morphology of yeast could not be regarded as a relative index to its true species. He corroborated the statements of previous investigators that there are distinct species of saccharomyces, and these may in some instances be identified by reference to their form and contour. But he showed that, under specific conditions of temperature and growth, one form could be made to assume that of the other. Thus *S. cerevisiæ* could be made to appear like *S. pastorianus* or *S. ellipsoideus*, and his researches made it quite evident that the mere appearance under the microscope might be entirely misleading. Indeed, I may say that I have myself examined in his laboratory pure specimens of his Carlsberg *S. cerevisiæ*, and have observed forms which, without reference to his researches, I should immediately have identified as *S. pastorianus*. I have been favored with preparations of this which I invite you to examine after the lecture, with the certain conviction that you will indorse what I have said respecting them.

Moreover, when he prepared ascospores according to the method of Engel, from pure cultures, he encountered a similar variety of forms. For instance, the asci, as will be seen by reference to the various diagrams,

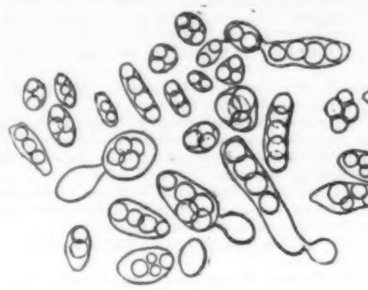


FIG. 17.—S. CEREVISIÆ I. ASCOSPORE FORMATION. (Hansen.)

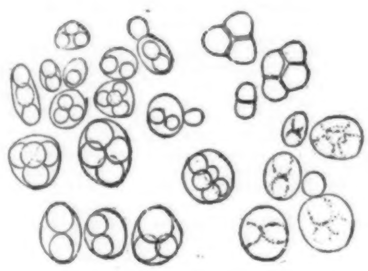


FIG. 18.—S. PASTORIANUS I. ASCOSPORE FORMATION. (Hansen.)

showed that some would develop spores in a pastorianus form of ascus, others in an ellipsoideus form, etc., although they might undoubtedly be derived from pure *S. cerevisiæ*. Hence it became necessary to further investigate the conditions of ascospore formation in order to ascertain wherein consisted the characteristics which allowed of the differentiation of the saccharomyces into their various species and varieties.

He achieved his object by forming ascospores from the various pure cultures at different degrees of temperature. His growths were made on blocks of plaster of Paris in the presence of moisture. His experiments in this direction were varied in every practical way, but in some notable instances he was unable to produce ascospores at all. Eidam, in attempting to repeat Reess' experiments, had failed to produce ascospores from any kind of saccharomyces whatever, and had gone so far as to deny his belief in the possibility of their formation; but Hansen showed him the source of his error in proving that they will only form from young and vigorous cells, and to secure their presence it is advisable to renew the wort from that first employed. Thus he allowed the sample first sown in the wort to vegetate for about twenty-four hours.

He then, with all possible safeguards against aerial

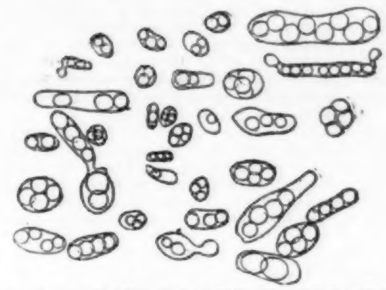


FIG. 19.—S. PASTORIANUS II. ASCOSPORE FORMATION. (Hansen.)

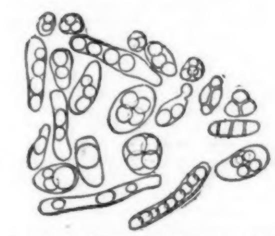


FIG. 20.—S. PASTORIANUS III. ASCOSPORE FORMATION. (Hansen.)

contamination, poured off the wort from the freshly sprouting yeast, replaced it with a fresh supply of sterile wort, and allowed the yeast to develop for another twenty-four hours. Then he considered that he had obtained fresh and vigorous cells, and he transferred them on sterilized glass scalpels to sterilized gypsum blocks. These he transferred to incubators kept at constant temperatures, and submitted the samples to frequent examination, so as to detect the appearance of the first rudiments of ascospores. His first experiments were undertaken with *S. apiculatus*. It was a form which Reess, the discoverer, had stated was incapable of forming ascospores, and Hansen confirmed and extended the observation by showing that it was unable to form them

* Lectures before the Society of Arts, London, 1888. From the *Journal* of the Society.

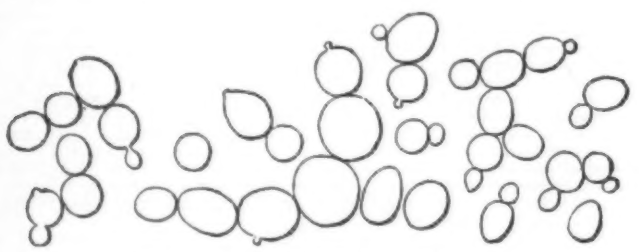


FIG. 11.—S. CEREVISIÆ I. (Hansen.)

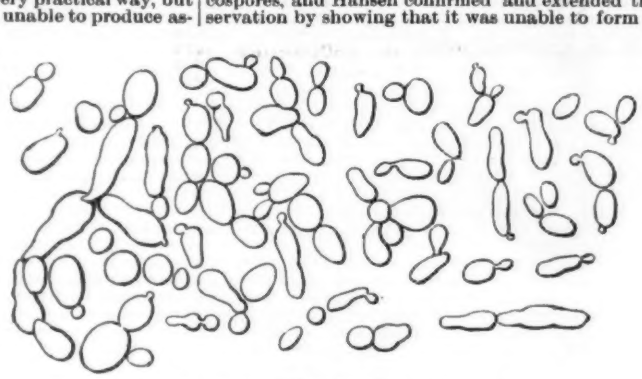


FIG. 12.—S. PASTORIANUS I. (Hansen.)

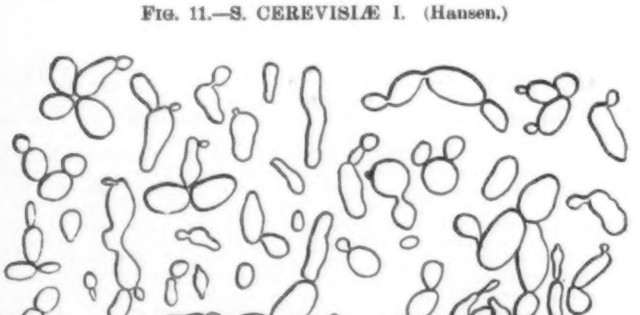


FIG. 13.—S. PASTORIANUS II. (Hansen.)

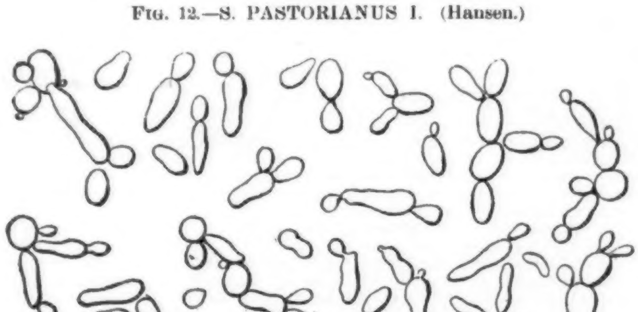


FIG. 14.—S. PASTORIANUS III. (Hansen.)

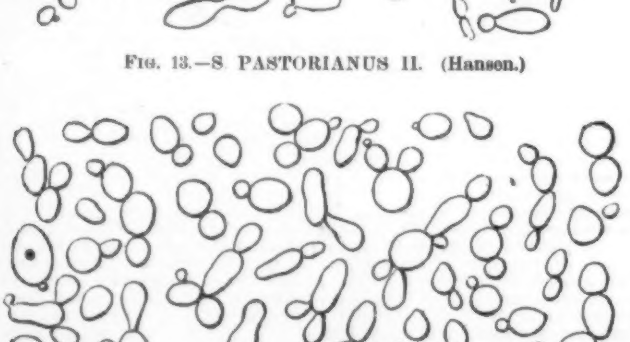


FIG. 15.—S. ELLIPSOIDEUS I. (Hansen.)

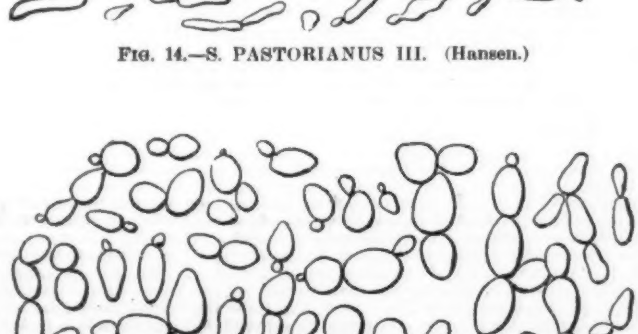


FIG. 16.—S. ELLIPSOIDEUS II. (Hansen.)

at any temperature within the limits of life of this fungus. He also showed that a statement by Engel as to the formation of a new form of organ of fructification, and the origination of a new species by *S. apiculatus*, termed *carpozyma*, was due to inaccurate working, and had no existence in reality. But his experiments upon the effects of temperature when undertaken with pure cultures showed Reess to have made some serious mistakes.

Thus he showed that *S. exiguus*, *S. mycoderma*, the so-called *torula* of Pasteur, and other forms stated to form ascospores, do not produce them at all under any conditions at present known. Hence it became apparent that these must, from the fungologist point of view, be as widely different from saccharomyces, which do form ascospores, as other sprouting fungi, such as *Dematium pullulans*, *Chalara mycoderma*, etc.

Indeed, Hansen has proved that, judged by their power of forming ascospores, which is the only really reliable test as yet known to us, we can at present only identify three species as constituting true saccharomyces; they are *S. cerevisiæ*, *S. pastorianus*, and *S. ellipsoideus*. Each of these species is known to form distinct varieties, and they have been designated by Hansen by means of Roman numerals. Thus he calls *S. cerevisiæ I.* a form of high fermentation yeast, similar to that employed in English and Scotch breweries. He has likewise examined other varieties, and has selected two for use in the Carlsberg brewery for pitching purposes. These he calls Carlsberg yeasts I. and II. Of *S. pastorianus* he has identified three distinct varieties, which are known as Pastorianus I., II., III., and two varieties of *S. ellipsoideus*, known respectively as I. and II.

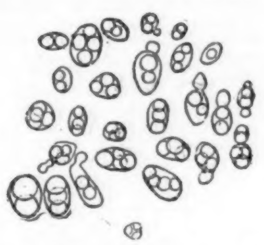


FIG. 21.—S. ELLIPSOIDEUS I. ASCOSPORE FORMATION. (Hansen.)

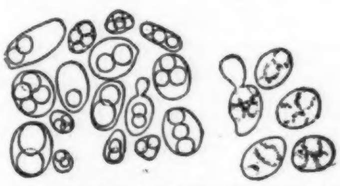


FIG. 22.—S. ELLIPSOIDEUS II. ASCOSPORE FORMATION. (Hansen.)

It should be clearly understood that the species as well as the varieties have been distinguished by variations in the conditions under which they form ascospores; but since it cannot for a moment be doubted that subsequent research will fail to discover fresh species as well as varieties, it necessarily follows that the nomenclature of the group must, for the present, be regarded as in a transition state. Sufficient has, however, been done to permit of a reliable limit being assigned to the term saccharomyces. It may, then, be provisionally defined as a group of fungi capable of inciting alcoholic fermentation when introduced into suitable media, capable of forming asci, and developing spores therein under certain defined conditions, and incapable of forming true mycelia. In these circumstances it is clear that the species hitherto included in the group, such as *S. apiculatus*, *S. exiguus*, *S. albicans*, *S. mycoderma*, *S. conglomeratus*, and *S. glutinis*, are not saccharomyces at all, and should be renamed when the investigations now in course of progress are concluded.

Hansen's discovery that the contour of a true saccharomyces is insufficient to determine its species will show at once how likely it was that Pasteur's experiments were undertaken upon mixtures of species and able from the original *Cerevisiæ* from which it was produced.

So it is with all the other species and all the other varieties. Particularly is it the case with the high and low ferment varieties. Hansen has tried in many ways to convert one form into the other. He has succeeded to this extent: that he has been enabled to make a low ferment acquire the typical attributes of a high ferment; has caused the carbonic acid disengaged during fermentation to attach itself to the cells, and enable the latter to rise through the wort, and having relieved themselves of the gas, to remain like a high ferment upon the surface of the wort. He has been enabled to do this through one generation after another so long as he subjected the yeast to the conditions favorable to the propagation of a high ferment *Cerevisiæ*; but immediately he transferred the new generation of cells thus developed to the low fermentation conditions of temperature and wort, the tendency to reversion was immediately manifested, and ultimately the original variety was fully re-established. It is scarcely necessary to insist that this is strong proof that both species and varieties are true and permanent.

Having thus decided what constitutes a true saccharomyces and what does not, the next question was how to distinguish between the true species themselves. In view of the fact that a microscopic examination in the ordinary way is absolutely useless for this purpose, Hansen determined the limiting temperatures of ascospore formation for each particular species in the manner I have stated. The following were the results obtained in working upon the six species above mentioned:

SACCHAROMYCES CEREVISIÆ I.

(*High fermentation.*)

Temp. F.		Time.
100	no development.	
97·0	appearances of distinct rudiments after	29 hours.
95·0	" "	25 "
92·0	" "	23 "
86·0	" "	20 "
77·0	" "	23 "
73·4	" "	27 "
63·0	" "	50 "
61·0	" "	65 "
52·0	" "	10 days.
48·2	no development.	

The diameter of the ascospores varies between 2·5–6 μ. The walls of the spores are generally more distinct than with the other species.

SACCHAROMYCES PASTORIANUS I.

(*Low fermentation.*)

Temp. F.		Time.
89·5	no development.	
85·0	appearance of distinct rudiments after	30 hours.
84·2	" "	27 "
83·0	" "	24 "
74·0	" "	26 "
64·4	" "	35 "
59·0	" "	50 "
50·0	" "	89 "
47·0	" "	5 days.
44·6	" "	7 "
38·0	" "	14 "
33·0	no development.	

The diameter of the ascospores varies between 1·5 and 3·5 μ, rarely to 5 μ. It is often present in the air of fermenting rooms, and corresponds closely with the form described by Pasteur and by Reess. *It has the power of communicating an intensely bitter taste to beer.*

SACCHAROMYCES PASTORIANUS II

(*Incites a feeble high fermentation.*)

Temp. F.		Time.
84·2	no development	
81·0	appearance of distinct rudiments after	34 hours.
77·0	" "	25 "
73·4	" "	27 "
62·6	" "	36 "
59·0	" "	48 "
52·5	" "	77 "
44·6	" "	7 days.
38·0	" "	17 "
33·0	no development.	

The diameter of the ascospores varies between 2–5 μ.

This form is also to be found in fermentation rooms, and corresponds in appearance with Pastorianus I. Indeed, if the two were blended, it would be impossible to distinguish them in a microscopic field. *It cannot be shown to exert any ill effects upon beer.*

SACCHAROMYCES PASTORIANUS III.

(*High fermentation.*)

Temp. F.		Time.
84·2	no development.	
81·0	appearance of distinct rudiments after	35 hours.
79·0	" "	30 "
77·0	" "	28 "
71·6	" "	29 "
62·6	" "	44 "
60·8	" "	53 "
51·0	" "	7 days.
47·0	" "	9 "
39·2	no development.	

The diameter of the ascospores varies between 2–4 μ. This variety, although a fairly vigorous high ferment, was obtained from a low fermentation beer. *It has been distinctly proved by its presence to produce cloudy and otherwise defective beer.* In normal circumstances the cells are in all respects similar to Pastorianus I.

SACCHAROMYCES ELLIPSOIDEUS I.

Temp. F.		Time.
90·0	no development.	
87·0	appearance of distinct rudiments after	31 hours.
85·0	" "	23 "
77·0	" "	21 "
64·4	" "	33 "
59·0	" "	45 "
51·0	" "	4½ days.
45·0	" "	11 "
39·2	no development.	

The diameter of the ascospores varies between 2–4 μ. Was found by Hansen, together with other varieties, on the external surface of grapes. Similar in appearance to that described by Pasteur and by Reess, and stated by the former to constitute the ordinary alcoholic ferment of wine.

SACCHAROMYCES ELLIPSOIDEUS II.

Temp. F.		Time.
95·0	no development.	
92·0	appearance of distinct rudiments after	38 hours.
91·4	" "	27 "
88·2	" "	23 "
84·2	" "	22 "
77·0	" "	27 "
64·4	" "	42 "
51·8	" "	5½ days.
46·4	" "	9 "
39·2	no development.	

The diameter of the ascospores varies between 2–5 μ. *It has been distinctly proved to be associated with the persistent clouding of beer in which it was present.*

The above temperature results have been expressed by Hansen as curves, and it is in that diagrammatic form that they are most strikingly instructive. I append one table in which the several curves are embodied.

It is evident that we have herein the elements of a system of analytical classification, for we have it proved:

1. That all sprouting fungi do not form ascospores under the conditions obtaining in Hansen's experiments.

2. That only the true saccharomyces form ascospores among the sprouting fungi.

3. That there are certain temperatures at which the formation takes place under the same conditions with varying degrees of speed.

4. That the temperature at which the greatest divergences with respect to time are manifested—other things being equal—is 11·5° C. (say 52° F.) Under these conditions *S. cerevisiæ I.* takes ten days to form its ascospores, whereas *Pastorianus I.* and *II.* require less than four days, *S. Pastorianus III.* less than seven days, *S. ellipsoideus I.* less than four and a half days, and *S. ellipsoideus II.* less than five and a half days.

The results will, however, not exhibit these divergences unless the directions are absolutely adhered to; for instance, Hansen shows that the time of ascospore formation will not be the same if the young cells are cultivated in the same wort for two days instead of one before being transferred to the gypsum blocks.

If, therefore, it is desired to ascertain whether a sample of commercial yeast contains *S. pastorianus* I., II., and III., or *S. ellipsoideus* I. and II., it is evident that the information may be afforded by cultivating the yeast as before indicated, selecting a number of single cells and producing ascospores from them at a temperature of about 52° Fahr. If none of the cells form ascospores before ten days, and do so after that interval, we may be certain that the culture is a pure one of *S. cerevisiæ* I. Of course, if it is required to operate upon bulk samples of other species, it might be more convenient to select some other temperature for incubation. This may be best determined by reference to the curve.

Another curious point in connection with ascospore formation is that described by Hansen under the German name of "Scheidewand," and shown in the illustrations (Figs. 17–20). Perhaps the best equivalent English expression would be "jointed formation." It sometimes happens that the spores cling to the wall of

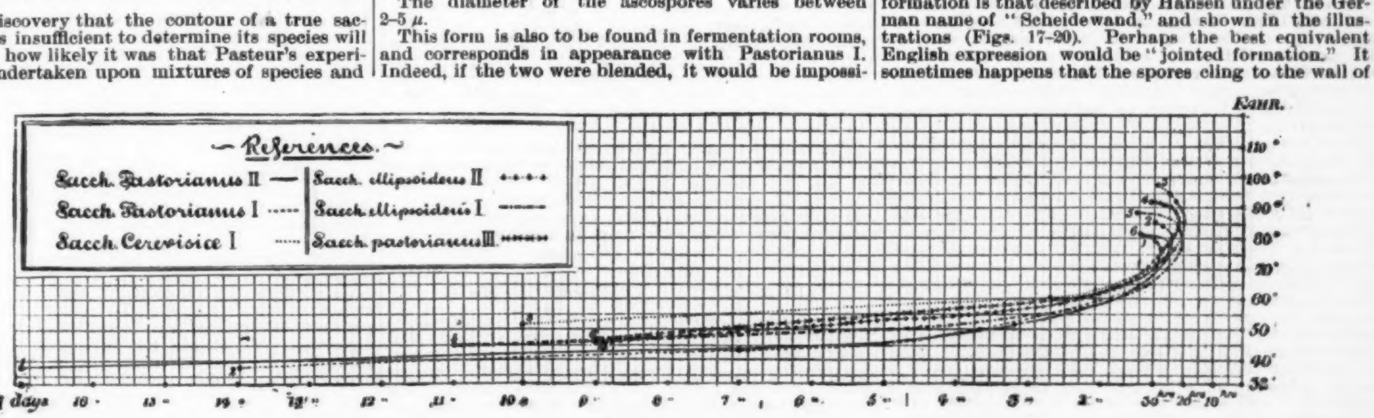


FIG. 23.

not upon pure cultures. But a very curious and significant fact remains to be chronicled with respect to this portion of his research. It might at first be supposed that the observations pointed to the feasibility of converting one species into another by propagation of the newly developed forms. This was proved impossible. Thus, by suitable modification of the conditions of growth, *S. cerevisiæ* may be made to assume say the *Pastorianus* form. By sowing the latter under the same conditions, the same *Pastorianus* form may be again developed by propagation. This may be repeated through many generations; but immediately on introducing the last generation into a wort at a temperature calculated to encourage the production of the original *Cerevisiæ* form, it will revert to it, and in the course of a few generations will be undistinguish-

the ascus, and adhere somewhat firmly thereto, and can only be detached by shaking. Sometimes, indeed, it needs to be very vigorously shaken before the spores are freed. The conditions of this "jointed formation" may possibly not yet be completely unraveled, and it is by no means improbable that it may subsequently be made available in connection with a more detailed analysis of yeast, when the investigation shall have become extended to all existing varieties.

It will be noticed that a somewhat low temperature is the most favorable to ascospore formation, that is a low temperature for high fermentation *S. cerevisiæ* as compared with its most suitable pitching heat for reproduction by sprouting. There is, however, a limit to be observed, because ascospores are not formed at too low nor at too high a temperature.

Hansen is most careful to impress upon brewers the fact that his results only apply to those varieties with which he has actually experimented. If, for instance, an English brewer were to desire to test the purity of his yeast by Hansen's method of analysis, he would have to determine for himself the conditions under which he would work, adhere to them most rigidly in every particular, and then ascertain the time required for ascospore formation at a fixed temperature for the particular variety of yeast employed in and suitable for his brewery.

We have now arrived at a stage in our work convenient for adjournment. In the next lecture we shall have to consider some few more investigations with reference to the botany of saccharomyces, and shall then proceed to examine the requirements of a wort suitable for its cultivation.

(*To be continued.*)

EXPOSURE OF M. PASTEUR'S METHODS.

DR. LUTAUD (Redacteur en chef du *Journal de Medecine de Paris*) has made a full and complete exposure of Pastorian methods, with the statistics and scandals relating to the modern French Cagliostro. The high standing of the author and the bold fight he has made against the greatest humbug and charlatan of the age are too well known to the readers of Parisian medical literature to need mention. In this work the life of M. Pasteur is fully presented to the reader, his character and motives dissected, and his claims to scientific recognition analyzed and exploded.

Dr. Lutaud will be accused of wildest heresy in not following blindly in the footsteps of modern medical men who accept Pasteur as a demigod, just as the equally great Parisian impostor, Mesmer, was accepted by European doctors in 1787, for his pretended discoveries in animal magnetism. History repeats itself, and never more strikingly than in the case of Mesmer and Pasteur—Pasteur, of whom Lutaud remarks: "The new prophet, he has created the foundation of a new church whose principal dogma is *Credo quia absurdum*."

To the mass of the profession and the public, who measure a man's reputation and ability by his popularity, the information that Pasteur is an arrant knave and impostor will be received with astonishment and regret—astonishment that the world is so easily duped, regret that the Utopian dreams of a medical Munchausen have not been realized. In France, where every man's pen is held responsible for every libel, and fine and imprisonment are common occurrences to editors, the boldness and bitterness, the keen invective of Dr. Lutaud's last diatribe deserve either punishment or vindication at the hands of outraged M. Pasteur and the French courts of justice. If the statements of Dr. Lutaud be true—and his statistics and corroborative testimony are presented in strong and unqualified terms—the followers and disciples of Pasteur should hide their heads in mortification and shame that men who have no belief in so-called theological mysteries should have an abiding faith in vague theories that even eclipse the moonshine myth of homeopathy. That a man entirely ignorant of medical training should turn the heads of the medical profession of France and England by the common artifices of the average impostor, is a fact which does not redound to the credit of modern medicine, which should be skeptical rather than credulous.

The pleas of Pasteur to national recognition have been based on a number of claims. Let us briefly analyze these claims, as fully evidenced in the latest word of Lutaud.

It is claimed that he has made France rich by curing the silkworm disease.

This assertion is utterly false. The departments Du Midi, where silk culture was most largely practiced, are ruined, and no longer have silk worms, save those imported from China. The French production of cocoons, which was formerly equal to thirty million kilogrammes, fell to eighteen million in 1865, the period when M. Pasteur was sent to investigate the cause and cure the disease. Since the Pastorian methods were resorted to, the production fell to four million kilogrammes. According to Pasteur, the disease of the silk worm was caused by a microbe, which he discovered through the microscope. Pasteur, in his official report, proclaims in bombastic French: "I am master of the malady, I can give the disease or prevent it as I will." The Pasteur treatment was adopted: those who sold the remedy—*at a high price*—made fortunes. Those who used the remedy (the farmers) ruined their crops. Last year's crop under Pastorian treatment fell to two million kilogrammes. For this wonderful scientific achievement France pays Pasteur a pension of 12,000 francs.

It is claimed that he made the grape growers of France rich by curing their vines of disease.

An arrant snob under the empire, M. Pasteur consecrated a work to that equally great imperial fraud, Napoleon III., with the introduction: "Sire, I hope that the time consecrated to my labor," etc. In this work Pasteur proposes an expert (*so-called*) to cure wines and vines. His treating apparatus for wine does not bring more than the ordinary price of old iron, and the grape vine disease has not been cured, although Pasteur's pension was now 25,000 francs per annum. This fact is lamented in a letter from Saint Vallier, ambassador of the French republic to Germany, which missive is duly incorporated in Lutaud's book, but is too lengthy for entire reproduction—the following short excerpt will suffice:

"It is a sad time in which we live, with false *savants* of the blow-trumpet order, of the Pasteur species, who are neither sages nor educated, not even practical men of ordinary common sense. Such men blow their own trumpets in the public dress parade."

Vine culture in France, it is needless to say, has not been benefited by M. Pasteur.

It is claimed he has made French brewers rich by pointing out an infallible method for manufacturing beer.

The Pasteur process is absolutely abandoned to-day, and never entered into general use. A company formed to run his patents quit the enterprise in disgust at their failure. *To-day the beer made in France is manufactured by the ordinary German process.*

It is claimed that Pasteur saved the herds of France from the terrible cattle plague.

According to Lutaud, "*The vaccination of cattle and sheep in France cost the country millions of francs.*"

The herds were attacked by pneumonias, catarrhal fevers, and other serious maladies—after inoculation by the brilliant Pasteur—and in Hungary the government commission declare in the official report that "Pasteur's inoculation tends to accelerate the action of other diseases in animals and hastens the natural issue of other grave affections." The Hungarian government prohibits its use in the extensive herds of that country, and to-day in France the practice is so fatal that the veterinary surgeons no longer use the method.

It is claimed that he made the farmers of France rich by curing and preventing chicken cholera.

This was another insertion of a Pasteur-discovered microbe for preventive and curative purposes. Out of 1,000 experiments there is only claimed to be one success. When practiced, the method is more disastrous to the chicken than the cholera. Late epidemics of chicken cholera in France—notably at Nancy—have demonstrated that the remedy is worse than the disease. Another pseudo-scientific patent remedy, invented by a charlatan who knew less of a duck's anatomy than of the sweet-voiced utterance of *Quack!* So much for Pasteur and chicken cholera.

It is claimed that he has made the hog raisers of France wealthy by curing the porcine disease.

Still playing on the credulity of people, with the microscope and newly discovered germs and the antique fake of inoculation as a preventive, the illustrious Pasteur now asserted that "a pig acquires immunity from hog cholera by vaccination." Why he should continually apply the term vaccination to all animals except the cow, is one of those mysteries known only to a French *savant* like M. Pasteur. This discovery resulted, as usual, in filling M. Pasteur's already bulging pocket book, and causing many a hog raiser to wish he had never tried the remedy, for the disease seems to have been communicated by inoculation. As usual, this was one of Pasteur's viruses that *kill* in place of being *preventive*. The Baron of Sevres of Monteil, president of a commission appointed by the French government, in his last report, states:

"Nevertheless, your commission is not sufficiently satisfied as to the immunity of hogs from disease after vaccination, and advise *prudence* on the part of stock raisers in using the method."

These claims for Pasteur, advanced by his friends—who seem to be legion—show how blind public opinion becomes at times, and how destructive the adoption of erroneous views may prove to the natural interests of society. That Pasteur is the most magnificent exhibition of what may be termed in vulgar parlance *monumental* cheek on record goes without contradiction, if we are to be influenced by Lutaud's work, which is fortified by full quotations from numerous official documents.

Scandals involving the co-called Pasteur filter, and other clap-trap inventions, are not to be wondered at, while the well-founded and positive statement—in fact, the notorious fact—that Paul Bert paid Pasteur a commission of 25,000 francs to use his influence to secure Bert's entrance to the Academy of Sciences goes without contradiction. When we come to consider that the Academy really designed to receive Davaine, from whom Pasteur stole all the ideas he ever had, the enormity and disgrace of the modern Cagliostro's crime cannot be spoken of in calm terms in the space allotted to a short review of a very large volume. Poor Davaine died of a broken heart from chagrin; Bert took his purchased seat in the Academy; Pasteur, the world-renowned scientist, pocketed the blood money, amounting to 25,000 francs, and started on a hunt for new microbes, pensions, and annuities.

The latest Pastorian fad is the cure and prevention of hydrophobia by inoculation. The humbuggery, associated with the murderous consequences to numerous deluded victims of his latest craze, has been treated at length by Dr. Lutaud, who shows full and concise statistics, with the names of the unfortunate fools who were destroyed as much by the *intensive method* of Pasteur as by the rabies, only serve to awaken horror and disgust. The saddest commentary on bacteriological medicine is the necessity of killing the patient in order to prove a theory.

To those who wish to study Pasteur as a man—a monster and a fraud—we cheerfully commend the work of our friend Lutaud—a French journalist, who is unequaled in keen satire, critical analysis, wonderful deductive power, and bravery, in a land where prison cells yawn for every man who indulges in a libel. Dr. Lutaud has defied Pasteur, and the illustrious scientist has his recourse in the French courts. If M. Pasteur feels himself wronged and maligned, he should order the arrest of Dr. Lutaud. Will the noble army of Pastorians insist on such action?—*T. C. M., in Lancet-Clinic.*

[The above caustic review of Pasteur's biological work is given upon high authority, as is evident from the opening sentence of the article. We trust that some of the votaries of Prof. Pasteur will answer it, and show how much can be done to confute its sweeping statements.—ED. SCI. AMERICAN SUPPLEMENT.]

[NEW YORK STAR.]

YUCATAN THE CRADLE OF MAN.

THROUGH all the ages, the question has been asked: "Where did man first appear on the earth?" Plato said he appeared on the Isle of Atlantis, lying between Central America and Africa. Herodotus stated that he interviewed the priests of Egypt, who declared that they came from the land of the West ten thousand years before the Father of History visited them. Was the land of the West Atlantis or Central America?

Alexander Winchell placed Adam, or rather the pre-Adam, on an island lost in the warm seas—Atlantis; and Donnelly has written a book descriptive of that mythical isle. Augustus Le Plongeon, the great explorer, claims that the oldest evidences of the existence of man on earth are to be found in Yucatan. As he has brought his proofs here from that peninsula, it is at least interesting to hear what he has to say and examine his collection of relics, which are certainly the most marvelous in existence.

Dr. Augustus Le Plongeon lives in Brooklyn at No. 204 Washington Street. I visited him and had an interview. He is a Frenchman by birth, classically educated, and now of advanced years. He married a lovely English girl whom he met in the British Museum. She became interested in his studies and placed her fortune at his disposal for exploration and accompanied him on his perilous expeditions. She has ever been his enthusiastic companion and supporter, and her name must live in history with his.

Dr. Le Plongeon said: I went to Peru in 1862 under the auspices of the California Academy of Sciences and remained there until 1870, making explorations. I came to New York in 1871, and then went to London, where I examined documents in the British Museum for six months and ascertained what could be learned there relative to the history of ancient Peru. In 1872 I came to New York, and in January of 1873 delivered an address before the Academy of Sciences, in which I stated that there was reason to believe from what I had seen in Peru that man had his origin in America. I was attacked for this statement, and made up my mind to go to Yucatan and settle the question if possible.

After arriving there I saw that a vast amount of work would have to be done, because nothing had been done, and before me lay a wealth of antiquities unknown to the world. There were at least forty cities overgrown with forests, and these so thick that one would never suspect the presence of ruins. Yucatan comprises 24,000 square miles. My investigations there lasted twelve years.

PERILOUS INVESTIGATIONS.

A war of races had been in progress for thirty-seven years, between the Indians and whites, so that it was perilous to prosecute the investigations alone. People advised me not to go to the ruins alone, but when they found that I was determined to do so, General Palonimo, commander of the Mexican forces there, volunteered an escort of 100 men, which was accepted. Merida was the capital of Yucatan, located twenty miles from the coast. From here we went to Chichen, one and twenty miles further. The nearest village was Silas, fifteen miles away, containing mixed races. There I employed sixteen men at $1 per day, and General Palonimo armed them. I am a Mason, and as the General was also, he was very ready to render me his powerful assistance and many valuable suggestions.

There were difficulties in the way of making photos., as we had only a little box in which to prepare the negatives. The wind moved the curtain and spoiled the light, and the men would peep in to ascertain what mystery was concealed, or we would find that the Indians placed in the background had moved, and blurred the negatives. Climate caused the ether to evaporate from the collodion. Plates got smashed. Out of over 1,000 negatives we made, only about three hundred remain.

All of the buildings stood on artificial terraces or pyramids. The ascent to these was generally by steep stairs; very often the stairs had disappeared altogether. In many cases we could only ascend by climbing some convenient tree. Once on top, we found all kinds of thorns, bushes, and debris. We were in constant danger from venomous reptiles and poisonous insects of vast varieties, wants, and tragic intentions. We stumbled over stones, fell on our noses, and there were continuous stiff breezes, which blew away our tape lines. The sun scorched us by day and insects bit at night. We had to examine each place where a foot was placed, on account of deadly vipers. All of the bushes were loaded with woodticks, which got under the skin and made us feel as if we had the smallpox. Nothing would take them off except a hot bath, which was impossible to obtain. We did not dare to leave our rifles out of sight for a moment. Such are some of the difficulties in exploring Yucatan. We conducted our work, notwithstanding, and measured every terrace, room, wall, stair, cornice, and door, and got the lengths and breadths, so that we can rebuild any of the structures at any time in facsimile.

INTERESTING DISCOVERIES.

Among the many interesting discoveries were statues of bearded men, very beautifully sculptured. There was one face with so long a beard that it appeared to the Indians to resemble me, and they insisted that it was me when I lived, thousands of years ago. On this account I became very much respected among the natives. There was one old rascal among the men who professed to know where everything was, and he guided us to a building which we very much desired to see. While showing us around the building he told us a wild story about a donkey which he declared lived in the walls, and he would not go in. The same party afterward betrayed us for $10. He assured us that in a certain portion of the building, which was closed up, a donkey could always be heard braying. The report caused the soldiers to break immense holes in order to find the animal, and the workmen assured us that for our desecration we would be turned to statues.

The most important discovery was made here. In a mausoleum we disinterred an enormous statue, weighing 5,000 pounds. With it were some urns containing the cremated remains of the individual whom it represented. This was the famous statue of Chaacmol, now in the National Museum of the city of Mexico. We were two months excavating down twenty feet below the mausoleum, to the statue. I translated the inscription on the mausoleum, and knew that below it was either a statue or a mummy. The work took so long a time because the mausoleum was composed of loose stones which fell down. To remedy this we made a palisade of saplings tied together with withes. The men were very stupid, not understanding what was wanted of them, and worked very unwillingly because they thought if they touched any of the antiquities they would die before the end of the year. We had to constantly watch them and urge them on, and even when they worked willingly they were very slow. Twice they openly revolted. One day when they revolted Mrs. Le Plongeon stood by the stack of arms and threatened to shoot them on the slightest provocation, while I repaired the damage they did in tearing down the palisades. We made ropes of saplings with which to haul out the statue. After we got it out we had no means by which to carry it away, and so we made a rude cart and a track. We pushed it five miles, making a road of levers as we went along.

A COLOSSAL THEFT.

The statue of Caacmol was hewed out of limestone and was beautifully flesh-colored. After going five miles with it we received orders from General Palonimo to disarm, on account of a rebellion then in progress. We could not ask the men to remain without arms, so we made a little house and left the statue in it on the cart, wrapped in oil cloth. While the revolution

was in progress we went to other ruins for seven months, hoping to get back to it. While we were away, one Peon Contreas, director of the Museum of Merida, proposed to the government that the statue should be searched for and placed in the museum at the capital. The government was pleased at the suggestion and sent an army to get it. It was at this time we were betrayed for $10. The soldiers took the statue to Merida, the streets of which were decorated and the houses festooned. It was greeted by vast throngs of people, bands of music, poems, prose writings, and speeches. In fact, no man was ever received with more honors than the great statue of Caacmol. The government wishing to be in the good graces of Diaz, offered it to Mexico as a present. The Mexican government accepted it, and sent a man-of-war, the Libertad, for it, and it was shipped at Vera Cruz and placed in the National Museum at the city of Mexico, where it remains to this day.

General Grant failed to take action on the subject of this colossal theft, as at that time he was encouraging railway connections with Mexico, and feared to complicate matters. The American Minister and Consul at Mexico also declined to interfere. I placed the matter in the hands of Senator Hoar, who brought it before the Senate, which ordered the whole thing printed. Here again General Grant begged to have the matter dropped, fearing to complicate the relations of the two governments. Thus we lost the results of our discovery of the statue, which had cost us over $1,000. We are still hoping for an administration which shall hold the honor of Americans in no small light, and which shall demand the immediate surrender of the statue so pregnant in the history of the dawn of civilization.

STATUES AND MASTODONS UNEARTHED.

We spent several months at the principal city of Uxmal, where we found objects of equal interest. Among these were exquisite works of art and a statue supposed to be that of the brother of Caacmol. This statue we carefullly concealed after making a mould of it. Only we know where it is hidden, and if we never secure it, I doubt if it can ever be found.

Caacmol was deified after death and worshiped in several countries under as many names. At Chicken we found a shrine erected to his memory. Here were many beautiful mineral paintings, probably the only vestiges now existing of ancient American art. They were on the walls, which were smoothly and beautifully plastered. The paintings were in vegetable colors, same as on the tombs of Egypt. They represent the history of the life of the individual buried beneath the mausoleum. We preserved facsimiles.

The mastodon was venerated by the Mayas because it was the largest animal in existence during their time. We found it sculptured on all the monuments. They considered it a fit object of worship. The same emblem appears in the Troano manuscript in many places. The mastodon faces are at the same time inscriptions and have their significant meanings. The mastodon probably became extinct about ten thousand years ago, and hence gives some idea of the age and time in which the Mayas lived, those lost races whose relics alone give an inkling of their history. At the same time these discoveries should stand as a vindication of William Cullen Bryant, who placed a picture of the mastodon being pierced with arrows by the aborigines in his history of the United States, and for which he was mercilessly ridiculed by his contemporaries. It also accounts for the elephant pipes found in certain of the Mississippi Valley mounds and now resting in the museum of the Davenport (Ia.) Academy of Sciences. It seems that it was these people who colonized the earth, because the words of their language and their customs, even the "red hand," appeared everywhere. The "red hand" marks of blood we found on the walls where they were placed thousands of years ago. The Egyptians always carried a corpse across the water, shouting, "To the West! To the West!" These signs of respect were the same in Ancient Mia, or Yucatan.

THE TROANO MANUSCRIPT.

The Troano manuscript was one of the books which escaped destruction at the hands of the Spanish priests under Bishop Landa, who accompanied the conquerors when they came to this country for conquest. It is a book on geology revealing all the facts about the lost Isle of Atlantis and what was known about the creation of the earth in the most remote times. It is a scientific work, not at all like the book of Genesis, as it confines itself to facts. This manuscript lies in the British Museum, where I secured a facsimile. I anticipated that I should find a key to it in Yucatan, and was not at all disappointed. On all the monuments I found beautiful inscriptions. I worked out the meaning of the Troano manuscript from the inscriptions, letter by letter. The way we ascertained the correctness of my decipherment was in that, whenever we followed the directions on the monuments, we discovered where certain statues were hid and many other objects whose history was on the monuments.

We spent in the excavations $48,000 of our private fortune and $5,000 advanced by Mr. Pierre Lorillard at the request of the late Sir Frederick Barlee, Governor of British Honduras.

In our later explorations we made casts of all the monuments and inscriptions in the buried cities of Uxmal and Chicken. These are not what are commonly called "squeezers," but hard, shaped on the stone with iron bands, nothing being lost, so that the plaster casts would be facsimiles. The object of making these moulds was to be able to reproduce the inscriptions in any city, so that students might study them without a journey. We have 400 of these moulds—enough to reproduce all the monuments, inscriptions, palaces, statues, etc.

GREEKS AND MAYAS COMPARED.

Let us see how other nations borrowed or rather migrated with their customs and language from ancient Mia, or Yucatan, the land of the Mayas. The Greek alphabet is a Maya poem, each letter a line thereof. The Egyptian and Maya dogs and the custom of cutting off or curling their tails are the same. The signs of respect, such as one arm crossing the breast and hand resting on the shoulder, are the same. They had the same dress and the same cut of garments. In the center of the pyramids the triangular arches are the same. The Freemason signs are the same. In Uxmal there is a three-room temple where signs exist which any Freemason can recognize. The Egyptians and Mayas had each five unlucky days in a year which are the same. Their measure of time was the same. Each had a civil year of eighteen months and thirteen days, with identical latitude and declination of the sun. Each people believed that after passing through certain transmigrations they would again return to earth. Each believed that on their return to earth they would use the same bodies, and hence the custom of mummies with the Egyptians, and of statues like the individual with the Mayas. Each people preserved the ashes of the dead, and used the same color, blue, at their burials.

I could go on indefinitely with similarities showing that the Egyptians came originally from ancient Yucatan when it was an immense continent, and before the submersion of the greater part of it. In these ancient times, some 12,000 or 15,000 years ago—and there is evidence that the Troano manuscript was written 8,000 years before the Christian era—the land of the Mayas, or Mia, as it was called, contained a population of over 260,000,000 people.

Dr. Le Plongeon ceased speaking at this point, and I spent several hours examining his marvelous material. I think his statements will bear scrutiny—certainly the evidence he presents is startling and overwhelming; and I hope he may find means to present it *in extenso* to the world in proper form.

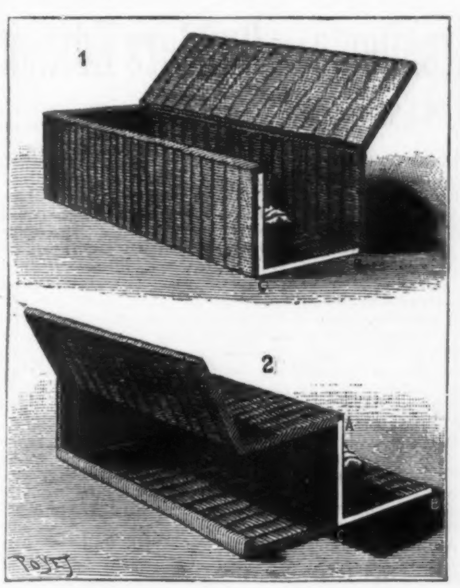
WILLIAM HOSEA BALLOU.

THE INDIAN BASKET.

AMONG the most remarkable experiments performed by prestidigitators should be cited that of the Indian basket, which, as its name indicates, is of Asiatic origin. Travelers in Hindostan have often told us that the Indians practice this wonderful trick upon the public places.

The Indian magician makes use of an oblong osier basket provided with a cover. He takes a child and incloses it in this basket, and around the latter buckles a belt. Grasping a sword, he thrusts it into the basket here and there, and pulls out the blade all dripping with blood.

The spectacle is shocking, and the feelings of the spectators become wrought up to a high pitch. The magician then opens the basket, which, to the surprise of all, is empty.



THE INDIAN BASKET TRICK.

At a few yards distance cries are heard proceeding from the child who had been inclosed in the basket, and who is now running forward sound and happy. Robert Houdin, who studied this juggler's trick, explained it perfectly, and was able to perform it himself. The basket used by the Indian prestidigitators is represented herewith.

Fig. 1 shows the basket open and ready to receive the child. For the sake of the explanation we have suppressed one end. This basket is provided with a double movable bottom, A C B, the center of motion of which is at C. In order to make the child disappear, the cover being closed, the top of the basket is lowered by turning it toward the spectators (Fig. 2). But the bottom, B, and the part, A, that depends upon it, do not take part in this motion. The weight of the child lying upon the bottom forces the latter to remain in place, and by this fact the part, A C, shuts off the bottom of the basket (Fig. 2).

In order to turn the basket over, the Indian fastens it with strips of leather, and, to facilitate this operation, places his knee on it. The child can then easily hide himself under the robe worn by the magician. Replacing the basket in its first position, the Indian inserts his sword and sticks the blade into a small sponge fixed within and saturated with a red liquid. While the attention of the spectators is absorbed by this exciting operation, the little Indian escapes from beneath the robe, and runs a short distance from the spectators without being seen. Houdin says that when this trick is well performed, it has a startling effect.—*La Nature.*

NEW YORK'S TWENTY-SEVEN PRIVATE HOSPITALS involve an annual cost of $765,781.44. Of this amount $440,884.65 has to be raised by private subscription. The city hospitals, over eight in number, cost about $355,000 annually. The hospitals, of New York, therefore, cost the people over a million of dollars annually.

[AMERICAN CHEMICAL JOURNAL.]

ON THE DECOMPOSITION OF ACETONE WITH BLEACHING POWDER.

By W. R. ORNDORFF and H. JESSEL.

IN the Annalen der Chemie, Vol. I., page 199, Liebig, after mentioning the formation of chloroform by distilling dilute alcohol with calcium hypochlorite, states that chloroform may also be obtained, and in greater quantity, if acetone be treated with calcium hypochlorite under the same circumstances. No other reference to the formation of chloroform from acetone occurs in the literature, if we except the statement of Siemerling* that the use of acetone for the preparation of chloroform is not advantageous, because the price of it is high and the product does not exceed one third of the acetone used. Notwithstanding Siemerling's statement, it has been found very advantageous to use acetone in the manufacture of chloroform, and at the present time a large amount of chloroform is actually made by the very method that Siemerling condemned. As there was nothing in the literature concerning the reaction which takes place when acetone is decomposed with bleaching powder, the present investigation was undertaken for the purpose of throwing some light on this subject.

The acetone used was a commercial product, boiling from 58° to 60° C. This was first dried over calcium chloride and then fractioned with a Hempel tube. The larger part of the acetone came over between 56° and 58° C., and this was used in all of the experiments. The bleaching powder was also a commercial article, and contained thirty-three and one third (33⅓) per cent. of available chlorine. The apparatus used consisted of a four-liter balloon flask provided with a three-hole rubber stopper. Through one of the holes passes a separatory funnel reaching to the bottom of the flask. The second hole has a glass tube of tolerably large diameter, which also reaches to the bottom of the flask. Through the third hole passes the exit tube, which is connected with a Liebig's condenser. The bleaching powder is placed in the flask, together with the requisite amount of water. A weighed quantity of acetone, after having been diluted with a certain quantity of water, is then gradually added through the separatory funnel. The reaction begins spontaneously, and the chloroform distills without the application of external heat. After all the acetone has been added, and the heat of the reaction has somewhat subsided, the flask is placed on a water bath and the bath heated. Steam is now passed through the mixture in the flask, so as to drive out all the chloroform. The flask must be shaken while the acetone is being added, and care must be taken not to add the acetone too fast, otherwise the flask becomes very hot and the mass is apt to froth over, owing to the chloroform distilling too rapidly. After a long series of experiments the following proportions were found to give the best results: 275 grammes of bleaching powder (33⅓ per cent. available chlorine) were mixed in the flask with 800 c. c. of water; 22 grammes of acetone were then diluted with 70 c. c. of water and gradually added through the separatory funnel. The yield of chloroform amounts to 166 to 173 per cent. of the weight of the acetone used. The chloroform obtained by this method was found to be very pure, and after being washed and dried, boiled constantly at 61·5°, and had the specific gravity of 1·5263 as compared with water at 4°.

The residues left in the flask in a long series of experiments were united and filtered. The solid material left on the filter was examined and found to be almost entirely calcium hydroxide, together with a small amount of calcium hypochlorite and calcium carbonate. Through the clear filtrate carbon dioxide was passed to remove the calcium hydroxide in solution, then it was filtered and the filtrate treated with a concentrated solution of potassium carbonate as long as any calcium carbonate was precipitated. The precipitated calcium carbonate was then filtered off and the solution of the potassium salts evaporated to crystallization. Two kinds of crystals were obtained, cubical crystals of potassium chloride and needle-shaped crystals which appeared to be potassium acetate.

Most of the potassium chloride was separated by fractional crystallization from water. The mother liquors were then evaporated to dryness on the water bath and the dry mass treated with alcohol (95 per cent.), in which potassium acetate is very soluble and potassium chloride almost insoluble. The alcoholic solution was filtered and the filtrate evaporated to dryness on the water bath. The dry mass was very deliquescent and absorbed moisture enough from the air to dissolve completely if allowed to stand unprotected. Treated with alcohol and sulphuric acid and distilled, acetic ether was formed. With a solution of ferric acetate it gave the characteristic precipitate of basic ferric acetate. A hot saturated solution, when treated with a strong solution of silver nitrate, filtered and allowed to cool, gave the characteristic flat, needle-shaped crystals of silver acetate. These were separated, recrystallized from water, dried, and analyzed, with the following results:

	Found.	Calculated for $Ag(C_2H_3O_2)$.
	64·47	64·67
Ag	64·57	

From these results it will be seen that the products formed by the action of bleaching powder on acetone are chloroform, calcium hydroxide, calcium chloride, and calcium acetate.

It is probable that the first action of the bleaching powder is a substituting one, yielding trichloracetone or methyl chloral, according to the equation,

$$2CH_3COCH_3+6CaOCl_2=2CH_3COCCl_3+3Ca(OH)_2+3CaCl_2.$$

This methyl chloral is then acted on by the calcium hydroxide formed at the same time, and chloroform and calcium acetate are formed thus:

$$2CH_3COCCl_3+Ca(OH)_2=2CHCl_3+Ca(C_2H_3O_2)_2,$$

or, combining the two equations,

$$2CH_3COCH_3+6CaOCl_2=2CHCl_3+2Ca(OH)_2+3CaCl_2+Ca(C_2H_3O_2)_2.$$

This equation requires for one molecule of acetone one of chloroform, or a yield of 206 per cent. of the weight of acetone used. The best yield obtained in the factory is 188 per cent. The amount of bleach-

* Arch. for Pharm. Trier [3] 53, 23.

ing powder required by this equation agrees very well with the amount found by experiment to give the best results.

In the Annalen der Chemie, Vol. I., page 228, Liebig says that if acetone be warmed slightly with a solution of calcium hyphochlorite, a strong precipitate of *calcium carbonate* is formed, and on distillation, chloroform passes over. As this statement is a direct contradiction of the above equation and the facts from which it was derived, a clear solution of bleaching powder was prepared by treating bleaching powder with water and filtering the solution, and then heated with a small quantity of acetone. A strong precipitate was thrown down at once, and the odor of chloroform was distinctly perceptible. The precipitate was filtered off and examined and found to be *calcium hydroxide*, and not *calcium carbonate*, as stated by Liebig, thus confirming the results obtained above. Acetophenone ($C_6H_5COCH_3$), treated in the same way, caused the clear solution of bleaching powder to become clouded, owing to the precipitation of calcium hydroxide. On distillation, chloroform passed over, calcium benzoate was found in the flask from which the chloroform was distilled. In this case probably trichloracetophenone or phenyl chloral is first formed, thus:

$$2C_6H_5COCH_3 + 6CaOCl_2 = 2C_6H_5COCCl_3 + 3Ca(OH)_2 + 3CaCl_2,$$

and this, with the calcium hydroxide formed at the same time, gives chloroform and calcium benzoate, thus:

$$2C_6H_5COCCl_3 + Ca(OH)_2 = (C_6H_5COO)_2Ca + 2CHCl_3.$$

Bischoff* and Colez † have shown that when acetone is treated with chlorine, trichloracetone or methyl chloral is the final product; and both Kramer ‡ and Morawski § have demonstrated that trichloracetone heated with a solution of an alkali yields chloroform. In order that there might be no doubt about this matter, acetone was treated with chlorine in the sunlight until it would absorb no more chlorine. The heavy oily product was then distilled with milk of lime, and chloroform was found in the distillate. Lieber, ‖ after giving a list of the substances which give the iodoform reaction when treated with iodine and caustic potash, states that all these bodies contain the methyl group, and that "man kann sich den Hergang bei der Reaction etwa so vorstellen, das KOH daran theilnimmt, indem H mit dem sich abspaltenden CH_3 und KO mit dem Rest in Verbindung tritt, während zugleich das Jod substituirend wirkt und so Jodoform bildet. Die Reaction findet nur dann statt wenn der vom CH_3 abgespaltene Rest geeignet ist, mit KO in Verbindung zu treten, d. h. entweder ein Säureradical ist, oder doch leicht sich durch Oxydation in ein solches verwandelt."

In the light of the results on the formation of chloroform from acetone and bleaching powder, it would seem that the formation of iodoform is in all respects analogous to the formation of chloroform, *i. e.*, that the iodine first acts as a substituting agent, giving a triiodo substitution product, and that this breaks up in the presence of the alkali, yielding iodoform and an acid residue which unites with the caustic alkali. The above process of making chloroform from acetone might well be substituted for the one ordinarily given in text books on organic chemistry, in which alcohol and bleaching powder are used. The yield of chloroform is much better, the process quicker and more satisfactory, and the explanation of the reaction, if anything, simpler.

[NATURE.]

ON THE INFLUENCE OF LIGHT UPON THE EXPLOSION OF NITROGEN IODIDE.¶

THE statement of L. Gattermann in his recent paper (*Berichte d. deutsch. chem. Gesellsch.*, xxi., 751; following up V. Meyer's paper in the same volume, p. 26) on nitrogen chloride, that its explosive decomposition may be brought about, or its susceptibility to explosion much increased, by exposure to bright light, has recalled to my mind the fact, which did not specially impress me at the time, that I myself undoubtedly observed the same relation several years ago in the case of nitrogen iodide.

In a paper on the preparation and composition of the latter substance, published in the first number of this *Journal* (April, 1879), it was noted that on two occasions the product obtained with the composition NI_3 or N_2I_3 "exploded in some quantity *under water* with much violence and complete shattering of the vessel."

I remember distinctly that in one of these cases I had just carried to a window, through which the sun was shining, the beaker full of water at the bottom of which was the black sediment of iodide, and was gently stirring the liquid with a glass rod, holding the beaker up so as to look at it from below, when the rod touched the lower part of the side or the bottom of the vessel, and the explosion occurred.

In the other case the iodide was being washed with ice cold water of ammonia, the vessel standing on a table exposed at the time to the direct rays of the sun. I do not remember with certainty what seemed to precipitate the explosion on this occasion, but I believe it was the pouring some fresh liquid, from the height of a few inches, on the black sediment of iodide, which had just been partially drained by decantation.

Under ordinary circumstances nitrogen iodide, while *wet*, exhibits no extraordinary sensitiveness, and may be safely worked with, only becoming highly dangerous on drying, so that I have little doubt that bright sunshine was influential in bringing about these two explosions.

J. W. MALLET.

University of Virginia, May 8, 1888.

EXCRETION OF SULPHURIC ACID.

DR. SERNEN B. SHER, of the Military Medico-Chirurgical Academy, St. Petersburg, has published, as a graduation thesis, a research on the relation existing between the total sulphuric acid excreted by the kidneys and that portion of it which is found in the urine in the form of a compound ether under conditions of rest and work. It is well known that a part of the sulphuric acid in the urine exists in combination with such substances as indoxyl, scatoxyl, pyrocatechin, phenol, cresol, etc., and several observers have written on the subject. Dr. Sher estimated the total sulphuric acid and that existing in the compound ethers in the urine of twenty-six persons under circumstances of both rest and work, keeping the results of the urine passed during the day separate from those of that voided at night. He found that the relation between the total acid and that combined with organic substances was altered very perceptibly by work, the mean total amount of sulphuric acid passed in the twenty-four hours without work being 2·75 grammes, or 8·2 times as much as the acid in a state of combination in compound ether, while when work was being performed the total quantity of the acid was 2·97 grammes, or 9·2 times the amount of the acid in the compound ethers. It therefore appears that the ratio between the two increases with work, but in cases where the work was very excessive and the physical powers exhausted thereby, the ratio was decreased. The total amount of sulphuric acid excreted was increased by work, if not excessive; the quantity of sulphuric acid excreted in the form of compound ethers, on the other hand, was found to be diminished by work, the mean daily numbers being 0·3334 gramme at rest and 0·3211 at work. Consequently, the effect of work is either to decrease the formation of aromatic acid in the intestines or to distribute these substances in the tissues by means of the muscular contractions and the increased formation of the blood. During the daytime more sulphuric acid is excreted than at night, both during rest and during work, the difference being greater during work than during rest, and the same rule holds good for the acid of the compound ethers.—*Lancet.*

* Ber. 8, 1339.
† Ann. chim. phys. [6], 9, 145.
‡ Ber. 7, 262.
§ J. prak. Chem. 1875, 388.
‖ Ann. Chem. Sp. Bd. 7, 230.
¶ Reprinted from the *American Chemical Journal*, vol. x., No. 4.

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